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American Foundryman

A PUBLICATION PRESENTING ASSOCIATION AND CHAPTER ACTIVITIES

More Pistons for Allison Motors (Courtesy Machinery, New York City)

Combined Analysis for Determining Phosphorus. See Page 2.
Precision Castings by Investment Molding Process. See Page 5.
Castings from the Consumers' Viewpoint. See Page 13.
Directory of Chapter Officers and Directors. See Page 19.

September
1944

Active Chapter Participation Is of Help to the Individual As Well as to the Association

IN sending a word of greeting to the members of A.F.A. I would like first of all to express my gratitude for the honor of being elected to the National Board, as representing our Canadian membership.

We are living in fast changing times and the fact that more and more "human relations" is one of the most important phases of industrial progress repeatedly is being brought to our attention.

This is definitely true as between labor and management, between buyer and seller, and should be in our case as between foundrymen. It is the art of cultivating fellowship and, within our foundry industry, that is one of the main functions of the A.F.A.

It has been demonstrated under the pressure of war that co-operation means progress, and this will be more than ever necessary in the change-over period and the conditions likely to follow the peace.

Our Association was designed for such co-operation, and it has amply demonstrated its success in the technical and practical fields of foundry work.

The work of the Association is climaxed each year in our highly successful Congress. To develop a meeting of such scope and to give each individual member an opportunity to participate, our chapter activities should be extended. Here the individual foundryman has an opportunity of fraternizing with foundrymen in his own territory for the discussion of local as well as general problems.

As one who is connected with the non-ferrous branch of the foundry field, I want to ask the members in the brass and bronze division to make use of the facilities of the Association.

Also, I should like to suggest that you contribute more of your time and effort in your local chapter, toward making the brass and bronze discussions interesting and helpful. Your ideas as to how this might be best accomplished will be beneficial to the whole Association.

JOSEPH SULLY, *Director*
American Foundrymen's Association.

JOSEPH SULLY, President, Sully Brass Foundry, Ltd., Toronto, Ontario, Canada, has been elected an A.F.A. Director for a three-year term. Since entering the foundry industry in 1921, Mr. Sully has been an ardent A.F.A. worker. He was instrumental in the organization of the Ontario Chapter, of which he is a past chairman, and he actively has participated in Association functions, particularly those of the Canadian membership.

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COLORIMETRIC METHOD
for Determining Phosphorus
IN A COMBINED FORM OF ANALYSIS

• *In a previous article appearing in the AMERICAN FOUNDRYMAN, the author described a method for the routine determination of silicon, manganese, phosphorus, chromium, nickel and molybdenum on a single weighing of sample of either plain or alloyed hard iron, malleable iron, gray iron, pig iron or steel. This article, explaining further development of the colorimetric method, supplements the previous work.*

By
W. B. SOBERS
Chain Belt Co., Milwaukee, Wis.

A COMBINED method of analysis has been applied to the analysis of non-ferrous metals, slags, ores, etc., where several determinations are made on a single weighing of sample. Why not apply a similar method for iron and steel analysis?

It should also be pointed out that, in the future, the iron and steel chemist will be measuring more of his chemical reagents in smaller amounts from a burette, replacing large volume graduates, and that colorimetric methods will play an important part in this trend, eliminating time-consuming operations. It may be of interest to note that a chemist by the name of Eggerts, as early as 1862, developed the color method for combined carbon.

The combined method of analysis, as previously outlined,[1] is a definite step in laboratory economy by shortening the time and requiring less chemicals for a given number of determinations. In addition, the author's laboratory has found the colorimetric method for phosphorus, in conjunction with the combined method, results in laboratory economy.

A colorimetric method for phosphorus developed at the Bureau of Standards,[2] in conjunction with the combined method, has been used. The method gives excellent results for both high and low phosphorus material, and the authors are to be congratulated for this efficient method which has eliminated the time consuming operations of precipitation, filtration and titration. An outline of how the colorimetric method is applied in conjunction with the combined method follows:

Unalloyed Cast Irons and Steel

Cast Irons

Treat a 1.0 gram sample with 5 ml. of dilute nitric acid (1-1) and 10 ml. of perchloric acid (70-72 per cent). Treat as outlined under Unalloyed Irons,[1] with the exception that 1 ml. of perchloric acid is used in place of nitric acid to dissolve the soluble salts (nitric acid interferes and must be completely removed). After filtering and washing into a 100 ml. volumetric flask, dilute to mark and mix.

Silicon and Manganese—Finish as outlined in previous article.[1]

Phosphorus—Pipette out 10 ml. of solution from the 100 ml. volumetric flask and transfer to a 100 ml. volumetric flask, dilute to mark and mix (1 ml. = 0.0010 grams). Pipette out 10 ml. (0.0100 grams) of this solution and transfer to a 250 ml. erlenmeyer flask. Add 2 ml. of perchloric acid and 15 ml. of sodium sulfite solution (see Table 1 for standard solutions).

Heat solution to boiling to reduce iron, resulting in a water white solution. Add 20 ml. of ammonium molybdate-hydrazine sulfate reagent, digest at 90° C. for 7 or 8 min. Then bring just to boil.

Cool, and when cold, transfer the solution to a 50 ml. volumetric flask and dilute to mark with a 1-4 solution of ammonium molybdate-hydrazine sulfate solution. Transfer back to erlenmeyer flask.

Transfer a portion of the solution to a matched test tube and measure the percentage transmission of the sample and obtain the percentage of phosphorus from a table or curve prepared from a series of samples of known phosphorus content, using the above method. Adjust the instrument to 100 per cent transmittancy for a matched test tube or cell filled with distilled water.

The blue phosphomolybdenum color is stable for several hours.

Plain Carbon Steel

Steels Containing Less Than 0.20 per cent Silicon—For steels containing less than 0.20 per cent silicon, use a 2.0 gram sample and treat with 5 ml. of dilute nitric acid and 20 ml. of perchloric acid. Treat as outlined in previous article,[1] catching filtrate in a 200 ml. volumetric flask. Transfer 5 ml. (0.0500 grams) to a 250 ml. erlenmeyer flask, add 5 ml. of water and 2.0 ml. perchloric acid. Treat as outlined above.

Steels Containing More Than 0.20 per cent Silicon—For steels containing more than 0.20 per cent silicon treat a 1.0 gram sample as outlined under cast irons. Transfer 5 ml. (0.0500 grams) from the 100 ml. volumetric flask to a 250 ml. erlenmeyer flask, add 5 ml. of water and 2.0 ml. of perchloric acid, finish as outlined.

Alloyed Cast Irons and Steel

Treat a 1.35 gram sample as outlined under "Alloyed Irons and Steel" in the previous article,[1] with the exception that 1 ml. of perchloric acid is used in place of nitric acid to dissolve the soluble salts. After filtering and washing into a 100 ml. volumetric flask, dilute to mark and transfer to a dry 400 ml. beaker. Flush out volumetric flask with 35

[1] Sobers, W. B., "A Combined Method of Chemical Analysis for Cast Iron and Steel," vol. 6, no. 1, AMERICAN FOUNDRYMAN, January, 1944, pp. 2-5.

[2] Hauge, J. L., and Bright, H. A., Research Paper R.P. 1386, JOURNAL OF RESEARCH, National Bureau of Standards, vol. 26, p. 405 (1941).

ml. of water. The volume is now 135 ml. (1 ml. = 0.0100 grams).

Steel

From the beaker, pipette out 5 ml. of solution (0.0500 grams) and transfer to a 250 ml. erlenmeyer flask. Add 5 ml. of water and 2 ml. of perchloric acid. Finish as outlined under UNALLOYED IRONS.

Cast Iron

From the beaker, pipette out 5 ml. of solution (0.0500 grams) and transfer to a 50 ml. volumetric flask. Dilute to mark and mix. Pipette out 10 ml. (0.0100 grams) of this solution and finish as outlined under UNALLOYED IRONS. Silicon, manganese, molybdenum, chromium and nickel are finished as outlined in previous article.[1]

BASIS FOR CURVES

The curve for cast irons (Fig. 1) is plotted from 0.110 to 0.520 per cent phosphorus based on a 0.0100 gram sample. If material runs higher than 0.520 per cent phosphorus, use a 0.0050 grain sample and multiply result by two.

The steel curve is plotted from zero to 0.099 per cent phosphorus, based on a 0.0500 gram sample. Zero per cent phosphorus was found by running the chemical reagents through the method minus the sample.

NOTES

To eliminate interference by chromium in irons and steels containing more than 2.00 per cent chromium, use 5 ml. in place of 2 ml. of perchloric acid and heat until fumes start coming off the mouth of the flask. Remove sample from heat and add a very small amount of sodium chloride (C. P.) to the sample.

Heat until fumes again start coming off the mouth of the flask. The orange-yellow color should disappear completely. If not, add another small amount of sodium chloride and again heat to fumes.

This procedure will eliminate all but a trace of chromium. Finish for phosphorus as outlined. This procedure is used by H. T. Peld, Sivyer Steel Castings Co., Milwaukee, for routine phosphorus determination on stainless steels. The method for the elimination of chromium was developed by F. W. Smith, Carnegie-Illinois Steel Corp., Chicago.

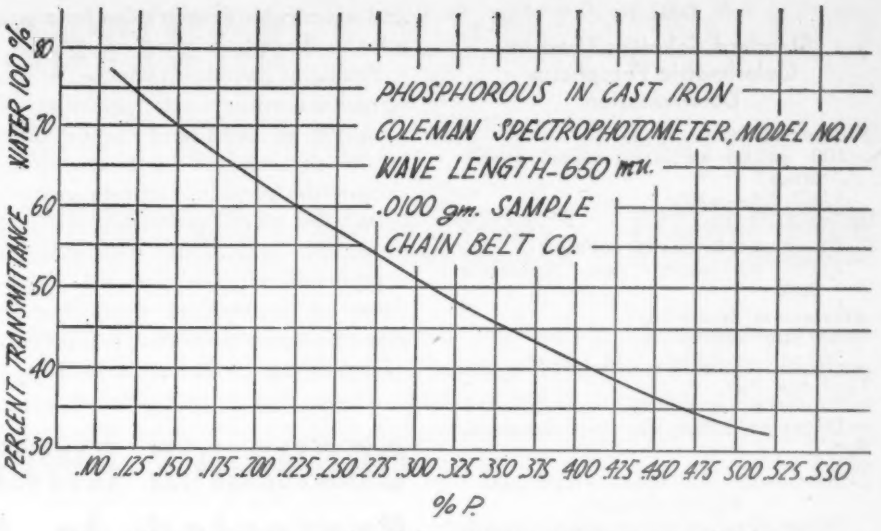


Fig. 1—Curve for cast irons, plotted from 0.110 to 0.520 per cent phosphorus.

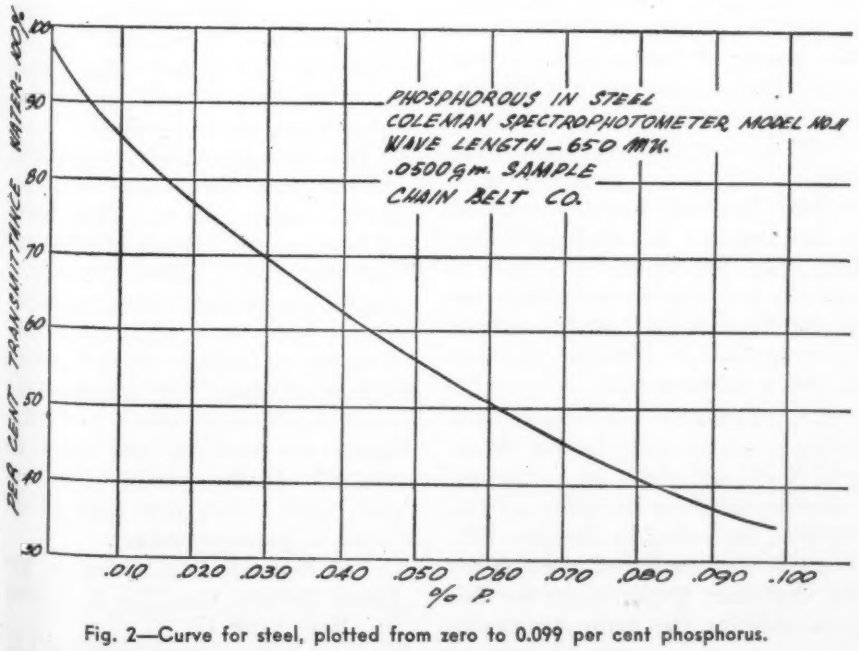


Fig. 2—Curve for steel, plotted from zero to 0.099 per cent phosphorus.

Since a combination of perchloric acid and sodium chloride results in no appreciable loss of aluminum, boron, cobalt, copper, iron, molybdenum, nickel, phosphorus, sulphur, silicon, titanium, vanadium or zirconium, there is a good possibility of applying this method for the elimination of chromium as chromyl chloride (CrO_2 Cl_2) for the determination of silicon, manganese, phosphorus, nickel and molybdenum in stainless steels, using the combined method of analysis. With chromium eliminated as chromyl chloride on the aliquots drawn off for the manganese, phosphorus and molybdenum determinations, the silicon and nickel can be finished as usual. Chromium then is checked on a single weighing of sample.

SAFETY INVOLVED IN HANDLING PERCHLORIC ACID FUMES

The laboratory fume hood and duct construction should be free of wood or any organic material. Transite, or a similar material, given a coat of suitable paint will be satisfactory, or any inorganic material. The duct work should be so constructed that it may be taken apart and cleaned free of any condensed chemical salt deposits or dust accumulations which may, over a period of time, form explosive mixtures.

CONCLUSIONS

There are developments in colorimetric iron and steel analysis to be worked out that may have far-

Table I

Standard Solutions Used in Colorimetric Phosphorus Determination

Sodium Sulfite
100 grams—sodium sulfite (anhydrous)
1,000 ml.—water.

Hydrazine Sulfate
1.5 grams—hydrazine sulfate.
1,000 ml.—water (use volumetric flask.

Ammonium Molybdate
600 ml.—water.
300 ml.—sulphuric acid (conc).

Cool and Add
20 grams—ammonium molybdate.
Dilute to 1,000 ml. (use volumetric flask).

Ammonium Molybdate—Hydrazine Sulfate Solution
Dilute 25 ml. of the ammonium molybdate solution and 10 ml. of the hydrazine sulfate solution to 100 ml (use volumetric flask). This solution is not stable and should be prepared as needed.

Diluting Solution
Dilute one volume of the ammonium molybdate hydrazine sulfate solution with four volumes of water.

reaching effects. All of the problems will not be solved over night. For example, a satisfactory colorimetric method for the determination of sulphur in plain and alloyed irons would be most welcome. Colorimetric methods for nickel, silicon, vanadium,, aluminum, copper, chromium, manganese, molybdenum, phosphorus, titanium and tungsten are in use today or they are in the state of development.

However, it is apparent that colorimetric methods of analysis, using optical or photometric methods to compare colors of solutions, offer more economical methods for the average metallurgical control laboratory than is offered by more elaborate and expensive equipment.

Book Review

Wood Patternmaking, 3rd Edition, 1941. Blue cloth binding, 339 pages. Published by the McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York. Price $2.25.

This book, which is designed for the student who desires to follow the occupation of patternmaking or who wishes to familiarize himself with the principles of the art, has a third revision. The text is based upon a series of problems which have been arranged in a progressive yet flexible manner, and which in the aggregate will constitute, within a certain range, a course of patternmaking and a desirable preparation for more advanced work.

Problems have been selected or designed according to the principles of molding involved and to the difficulties encountered in the construction of the pattern. Definite instructions are given pertaining to the order of operations required for completion of these patterns. Repetition of instructions appearing in text may seem unnecessary, but years of experience as an instructor in patternmaking have convinced the author that too much emphasis cannot be placed upon certain features.

Chief among the new features contained in this revised edition are an example of follow-boarding a pattern, mounting a pattern upon a match-plate, lagging over batten foundations, the use of superimposed cores, and obtaining the maximum use of the machine tools. The book also contains a glossary of terms used in patternmaking and molding.

ORDNANCE AWARD
Presented to Battelle Institute

ON THE staff of the Battelle Memorial Institute are men who work closely with the American Foundrymen's Association. Their participation in the Association's activities, particularly through their technical and committee work, has been of real benefit to the industry.

Therefore, the recent announcement that the War Department has granted the Ordnance Distinguished Service Award to the Institute will be of interest to A.F.A. members. Word of the recognition was received from Major General L. H. Campbell, Jr., Chief of Ordnance, who wrote to Battelle Director Clyde Williams:

"It is my pleasure as Chief of Ordnance of the Army to tell you on behalf of the Ordnance Department that I am most grateful for the outstanding contributions the Battelle Memorial Institute has made to ordnance progress in this war. The degree of that progress is best shown by the success of our fighting forces in all theaters of operations.

"To attest the appreciation of the Department for the splendid services of your Institute, I wish to present to the Institute the Ordnance Distinguished Service Award. It is a diploma bearing the traditional seal of the Department and is awarded in recognition of scientific and engineering achievement."

Battelle Institute has been actively engaged in research for the Army and Navy and other governmental war agencies since the early days of the war, according to Director Williams. It has conducted research for the Ordnance Department, the Bureau of Ships, the Army Air Corps, the Watertown Arsenal, the War Production Board, the Defense Plant Corporation, the Office of Scientific Research and Development, the National Defense Research Committee, the National Academy of Sciences, and others.

Numerous reports on scientific developments have been issued to military and other governmental authorities, and Battelle developments have been incorporated into the machines and production processes of war. In addition to its government-sponsored research, Battelle has been working continuously on scores of war research projects for private industry.

"How to Cut Waste" Compiled for Foremen

GLEN GARDINER, using a series of articles from "Management Information" as a basis, has prepared a manual entitled "How to Cut Waste" that should be of interest to foremen, department heads and supervisors.

The 38-page booklet approaches the subject of waste from many important angles such as: "The Waste of Manpower," "Waste of Materials and Supplies," "How Machinery and Equipment Are Wasted," "Waste of Work Space," "How Wasteful Accidents Are Caused," "Cause of Waste," "Waste Resulting from Non-Cooperation," and "Enlisting Workers in the War on Waste." It also provides the foreman with a four-step plan to cut waste in plant operation.

The material is published by the Elliott Service Co., 219 East 44th St., New York 17.

PRECISION CASTINGS

Employing Dental Technique

BY INVESTMENT MOLDING PROCESS

• This article, which was presented at a session on centrifugal castings at the 3d War Production Foundry Congress, Buffalo, explains how precision castings can be made by the investment method. The work will be presented in installments in the AMERICAN FOUNDRYMAN. Part 1 reviews the history of the process and shows how the dental technique is employed.

Presented by
ROBERT NEIMAN
Whip-Mix Corp., Louisville, Ky.

OUR country's war production program has emphasized the need for a method of producing precision metal parts of intricate shape from alloys difficult to machine. Such a method has been in use for several decades for the production of dental and medical appliances and for some cast jewelry.

It has been adapted successfully in the production of many vital aircraft and armament parts. This method is known as the "investment process" and involves the use of wax patterns. It also is known as the "lost wax" process (French cire perdu).

The investment process is used in comparatively few plants to date, these being principally dental or jewelry manufacturers or their licensees. There is a wealth of literature on the dental technique but practically none on the actual principles and technique of commercial investment casting. The purpose of this paper is to tell what the investment process is, how it is carried out, and when, where, and why its use is indicated.

Before beginning the detailed study of the physical principles of precision casting and their practical application, it is perhaps advisable to predict that this method will find its place in post-war time alongside the recognized metal forming and shaping operations, including sand casting, die casting, hot forming and forging, cold drawing, stamping, and machining.

Other important new methods include plaster casting and powder metallurgy. Each method has its advantages for certain applications. It is hoped that precision casting will be given an equal chance, through sponsored and continued research, by those concerns capable of doing so.

Historical

Dentistry

Wax patterns were used in the production of artistic castings in the 16th century by Benvenuto Cellini. Like other of his contemporaries, artistic countrymen such as Raphael and Stradivarius, he kept his method secret. The "lost wax" process, however, was rediscovered in 1897 by a dentist, B. F. Philbrook of Iowa.[1*] Real recognition for discovery usually is given to W. H. Taggart.[2]

Dr. Taggart gave emphasis to his invention by introducing a complete casting outfit and necessary materials to the dental profession. Although materials and methods have been improved greatly and perfected, the original process is still essentially the same.

The dentist must produce a single gold casting that will be an exact replica of the missing tooth structure, his object is very small and irregular; he can not enlarge his wax pattern (by the shrink rule), accurate to better than a thousandth of an inch.

After the dentist prepares the wax pattern, the rest of the investment process can be carried out by a comparatively inexperienced assistant. That such an accurate process can be so simple and comparatively foolproof is a tribute to the constant research being carried out by dentists, dental schools, the American Dental Association Research Fellowship at the Nation Bureau of Standards, and the dental manufacturers.

Jewelry Manufacture

It is little wonder that this ingenious process should be adapted to a related art, the casting of precious alloys for jewelry. The jeweler is not so demanding in dimensional accuracy but does require intricate shapes with smooth surfaces and minute detail, with the further requirement of many similar castings from one master.

War Production

With the advent of this war, especially with the entrance of the United States, the dental and jewelry industries had the opportunity of utilizing their science and art to help build the mighty "Arsenal of Democracy."

It has been demonstrated by the New York Jewelry Crafts Association[3] that the centrifugal casting of small ordnance and aircraft parts can be done with a resultant saving of large quantities of strategic materials, thousands of man hours, and countless machine tools. Above all, it reduced tool-up time from months to a matter of days.

Another example of a known use of the investment process by dental methods, is the casting of turbosupercharger buckets from chromium-cobalt-tungsten alloys of the type used in dental and medical appliances. These alloys are extremely corrosion resistant and have high hot strength, but are difficult to forge or machine. These are being precision cast by several companies who utilize centrifugal as well as pressure casting methods.[4, 5]

The company with which the author is associated formed a division to produce precision cast air-

*Superior numbers refer to bibliography at the end of the paper.

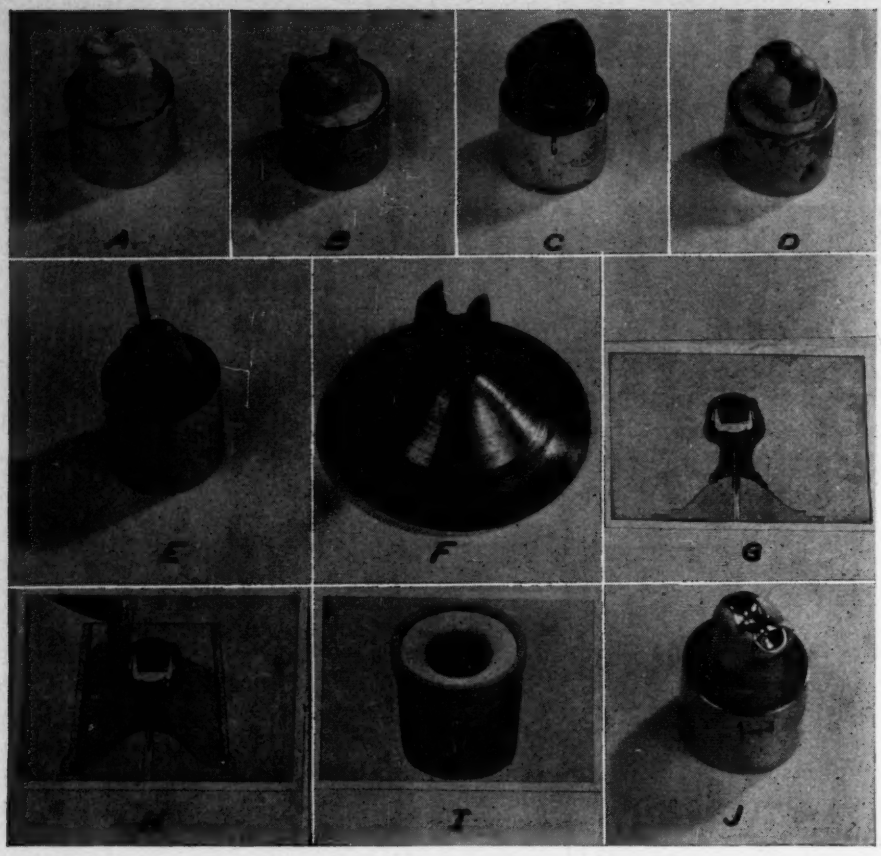


FIG. 1—DENTAL TECHNIC FOR CASTING INLAYS. A—TOOTH IN NORMAL HEALTHY CONDITION. B—DECAYED TOOTH WITH ADJACENT TOOTH STRUCTURE REMOVED TO PROVIDE CAVITY CAPABLE OF HOLDING INLAY. C—COPPER BAND, CONTOURED TO FIT TOOTH SNUGLY, IS FILLED WITH SOFTENED INLAY WAX, PUSHED ONTO THE TOOTH AND HELD UNDER FINGER PRESSURE UNTIL THE WAX COOLS AND HARDENS. D—COPPER BAND IS SLIT AND REMOVED AND THE WAX IS CARVED UNTIL THE REMAINDER RESEMBLES ORIGINAL TOOTH STRUCTURE. E—WIRE OR PIN (SUCH AS 14 GAGE) IS HEATED AT ONE END AND INSERTED INTO PATTERN. AS THE PIN COOLS THE SURROUNDING WAX HARDENS AND HOLDS IT SECURELY. F—PATTERN IS LIFTED OFF THE TOOTH, USING THE PIN AS A HANDLE. IT IS INVERTED AND SET IN THE CRUCIBLE FORMER. G—PATTERN AND SPRUE IS PAINTED AND BUILT UP WITH A ⅛-IN. THICKNESS OF INVESTMENT MIXED TO A CREAMY CONSISTENCY. H—A METAL RING OR FLASK IS SET ON THE CRUCIBLE FORMER SURROUNDING THE PAINTED PATTERN. THE RING IS FILLED WITH ADDITIONAL INVESTMENT. AFTER THE INVESTMENT SETS ½ HR. THE CRUCIBLE FORMER IS REMOVED AND THE WIRE PIN PULLED OUT, LEAVING A SPRUE HOLE LEADING TO THE PATTERN. I—THE RING OR FLASK IS PLACED IN FURNACE FOR ½ TO ONE HR. AND HEATED TO DULL RED HEAT (1200° F., 650° C.). THE WAX PATTERN VOLATILIZES AND DISAPPEARS, LEAVING A HOLLOW PATTERN CHAMBER. THE FLASK IS SET IN A CASTING MACHINE, METAL PLACED IN THE CRUCIBLE, MOLTEN AND FORCED INTO PATTERN CHAMBER THROUGH SPRUE HOLE. J—MOLD IS PLUNGED IN WATER, INVESTMENT REMOVED AND SPRUE CUT OFF. REMAINING CASTING IS READY TO BE CEMENTED IN TOOTH.

craft and armament parts by the investment process, utilizing centrifugal as well as air pressure methods.

Typical methods used by precision casting manufacturers will be used throughout this paper to illustrate the various principles of the investment process.

DENTAL METHODS

Precision casting by the investment process using wax patterns (or disappearing patterns) is essentially the same as dental casting but on a larger scale. The dentist makes inlays weighing 1/10 oz., the jeweler makes ½-oz. rings and the precision caster has made castings weighing one lb. with 5-lb. castings in the offing. Casting sizes can be increased far beyond this with larger equipment and continually improved materials. The precision caster looks with awe at the foundryman pouring ton castings. The foundryman looks with amazement at the comparatively tiny precision casting. Foundry practices vary quite a bit in the two industries, but there are many points of similarity. A mutual understanding of these practices should aid the foundryman in his search for greater accuracy and quality, and the precision caster in his desire for quantity and increased casting size.

Procedure in Making an Inlay

The basic fundamentals of precision casting are found in the dental method of producing a cast inlay restoration. A step-by-step description of the method follows. It must be remembered, in the description, that the work of producing and carving the wax pattern is done on the tooth in the patient's mouth at a temperature of 95 to 98° F. Steps A to E, Fig. 1, are performed at that temperature. After the wax pattern is removed from the patient's mouth, it is handled in the laboratory at room temperature (appr. 75° F., av.) until cemented in place on the tooth in the mouth. Figure 1 illustrates and describes the various operations in making a gold inlay.

PHYSICAL PRINCIPLES OF SHRINKAGE COMPENSATION IN PRECISION CASTING

The practical method having been described, it is now advisable to enter into a discussion of the physical principles that serve as the basis of all processes for producing accurate castings in investment. The dental process for producing accurate cast gold inlays or fillings will be used as an example throughout the following discussion because it is well established on a scientific basis through years of study in commercial laboratories, universities and, especially, at the Bureau of Standards. These principles should be well understood as they are the basis of casting any alloy in any size in any quantity.

In any casting process, the goal is a casting of a given size. With this as a given or fiducial point, we must determine all shrinkages in the process, sum them up and compensate for these negative quantities by an equal summation of expansion or positive quantities.

Foundry Methods of Calculation of Shrinkage

The foundryman has one shrinkage with which to contend, namely, the casting shrinkage of the metal. For example, if a certain brass shrinks ¼ in. per ft., the sand founder will use the shrink rule and add ¼ in. per linear ft. to his patterns. Thus when the pattern is removed from the sand, it leaves a mold cavity ¼ in. per linear ft. larger than the finished object. Metal is poured into the cavity, whereupon it solidifies, cools and shrinks ¼ in. per ft. so that the finished casting is the size required.

When a foundryman makes a match plate, he first produces a master pattern to which a "double

shrink" is added. One shrinkage allowance covers that from the single master to the match plate. The second shrinkage allowance is from the match plate to the practical casting. For example, using a brass with a shrinkage of 7/32 in. per ft., or 1.82 per cent, double shrinkage would be 3.64 per cent.

Precision Investment Method

Wax Shrinkage. The dentist is confronted with different conditions, including a double shrinkage and a double expansion, but again careful balancing of the ledger will produce the desired results. First, the shrinkages will be considered. Since the pattern that forms the mold cavity is wax, its thermal changes affect the mold size. The wax is adapted to the tooth cavity (which is our fiducial point) at mouth temperature which is very nearly 95° F.; the pattern is then handled at room temperature, usually 75° F. (average year around in dental offices) so that it cools 20° F. From an expansion (and contraction) curve of a typical pattern wax (Fig. 2), it is seen that the shrinkage from 95° F. to 75° F. is 0.35 per cent minus 0.10 per cent or 0.25 per cent.

Metal Casting Shrinkage. The other shrinkage is the casting shrinkage of the gold alloy. This has been determined to be 1.25 per cent. This figure was determined, along with many other physical properties of dental materials, in the classical work of R. L. Coleman.[6]

The total shrinkage is thus 0.25 per cent plus 1.25 per cent, or 1.50 per cent.

Compensating Expansions. This may be compensated for by the following modes for expanding the mold cavity:

(1) Heating the wax pattern.
(2) Setting expansion of the investment.
(3) Thermal expansion of the investment.

No. 1 was used before the advent of high-expanding investments. It was carried out by covering the wax pattern with an investment mixed with hot water. Thus, if the pattern was covered in investment at 115° F., the wax would expand 0.5 per cent. This took place before the investment set hard. Since another 1.0 per cent for complete compensation is needed, an investment with 0.3 per cent setting expansion and 0.7 per cent thermal expansion would be used.

At present, the dentist uses, for example, an investment with 0.3 per cent setting expansion and which will expand thermally upon heating to 1200 to 1300° F. (649 to 704° C.), an additional 1.2 per cent. Thus, 1.2 per cent plus 0.3 per cent equals 1.5 per cent.

Obviously, all dentists do not use the same wax and same type of investment nor work in a 75° F. room, nor are all inlays the same size and shape. The dentist must study the conditions and compensate accordingly. Simple yet accurate means for doing this are furnished by the investment manufacturer.

Materials

The principal materials and equipment used by the dentist, jeweler and precision caster are as follows:

(1) Waxes

A dental inlay wax must become pliable at about 110 to 125° F. (43 to 52° C.) so that it can be softened and applied to the tooth structure without undue discomfort. It must be quite hard at mouth temperature so that it will not distort upon removal. It should be easily carved without flaking and be of a dark color so as to be easily differentiated from tooth structure. It must volatilize and burn away without leaving any appreciable ash. Details, test methods and specifications were developed at the Bureau of Standards.[7]

Inlay waxes consist of a paraffin base with proper working characteristics controlled by compounding with one or more of the following: beeswax, carnauba, candellila, ceresin, damar and stearin, as well as new synthetic waxes. Coleman[6] gives the following formula: paraffin 60 per cent, carnauba 25 per cent, ceresin 10 per cent, refined beeswax 5 per cent. Others will be found in Appendix I at the end of the paper.

Waxes have unusually high coefficients of expansion. They will change in dimension quite a bit with a small change in temperature (Fig. 2). Wax patterns should be invested as soon as possible after removal from the tooth as they are highly subject to distortion, losing accurate shape even in a few hours. This is variously explained as being due to elasticity and the tendency of the wax to return to its former shape before being stressed and forced into position. Waxes consist of a mixture of crystalline and amorphous materials and are thus subject to plastic flow (even under their own weight).

Some of the latest developments in pattern materials include the use of plastics and low fusing metals.[23] These are indicated where extreme

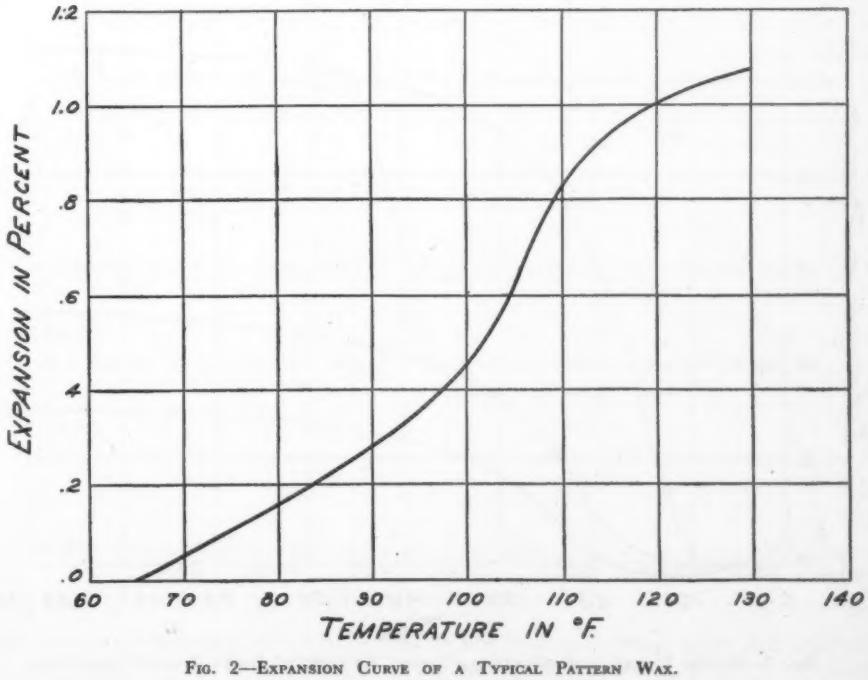


Fig. 2—Expansion Curve of a Typical Pattern Wax.

accuracy is necessary. The cost is greater than that of wax, but even this is being overcome.

(2) Investment

The dictionary defines this word as "the act of surrounding, that which invests or clothes; dress, vestment." In casting work, investment means the material that surrounds or covers the patterns. It is the mold-forming material and the counterpart of the foundryman's sand.

Investments vary widely in composition, but all of them consist of a refractory aggregate (such as powdered silica) and a binder (such as plaster of paris) which will form a creamy fluid mixture when mixed with water. This will flow or can be vibrated into place and will set or harden to a hard, cementitious mass. Typical investment formulae are given in Appendix II at the end of this paper.

In the foundry, the sand molds almost invariably are used at room temperature; therefore, no expansion nor contraction due to heating or cooling takes place. With investments, the conditions are different. Expansion takes place during the setting or hardening and is known as setting expansion.

Investments also expand during their heating to volatilize the encased or invested patterns, and will contract if they are cooled before casting. These expansions and contractions control the cavity size and shape and must be controlled accurately and their values accurately measured. It should be noted that if the investment expands, all cavities (pattern chambers) therein expand in the same proportion. Likewise if the investment contracts, all cavities therein will contract. For example: if the investment has a thermal expansion of 1.0%, the investment and all cavities therein will expand 0.010 ins. per inch (regardless of investment mold or cavity size or shape. The following section will develop the properties of investments.

Setting Time. Investments should form a plastic mass of the consistency of thick cream and maintain such for about 3 to 5 min. to permit painting and investing of the pattern. Setting time may be varied to suit the need.

Strength. The crushing strengths of investments (dry, at room temperature) are from 1000 to 3000 psi. and rarely cause trouble on this score. Hot strengths are about 400 psi.

Fineness. Since the cast inlay can not be ground or polished on the side to fit the cavity lest the perfect fit be destroyed, the cast surface must be extremely smooth. Bureau of Standards Specifications[15] call for a fineness of investment materials such that all shall pass a no. 30 sieve, 95 per cent shall pass a no. 100 sieve, 85 per cent through a 325 sieve. The average particle size is about 500 mesh, and is many times finer than the finest foundry sand. Commercial dental investments are being used for precision casting work. Modifications are made to suit the user's process.

Permeability. Since the metal is forced into the mold under pressure (10 to 30 psi.), the investment can be dense and thus present a hard, dense, smooth surface. The permeability of the mold at 1200° F. (649° C.) or casting temperature has never been successfully measured, but from measurements at room temperature it has about 1/10 the permeability of an average sand. Permeability is controlled by investment particle size and shape, and by the amount of gaging water used. More water increases permeability.

Chemical Properties. The investment should not contain any ingredients that will react with the molten casting alloy to cause undue gas evolution, oxidation, or other chemical reaction. These would destroy the physical properties of the casting and the surface finish would be unsightly as well as too rough to meet accurate specifications. The investment formulas given in Appendix II show examples of the wide variety of ingredients used to give desired chemical as well as physical characteristics to investments.

Setting Expansion. Plaster of paris, the most universal investment binder (except for casting high-fusing ferrous and cobalt-chromium alloys), expands on setting and imparts this property to investments. Plaster expands from 0.2 to 0.5 per cent and investments do likewise. The three curves in Fig. 3 show the setting expansion of a typical investment (Type 6—Appendix II) under various conditions. In the curve marked "dry," Fig. 3, which shows the setting expansion in air, note that the maximum expansion is reached in about one hr. and that there is no appreciable subsequent change even in 24 hr.

Plaster of paris (and its investments) will expand even more if permitted to set in contact with or immersed in water. This is known as hygroscopic expansion. The setting expansion can be increased by lining the investing ring with a thin strip of wet asbestos paper before

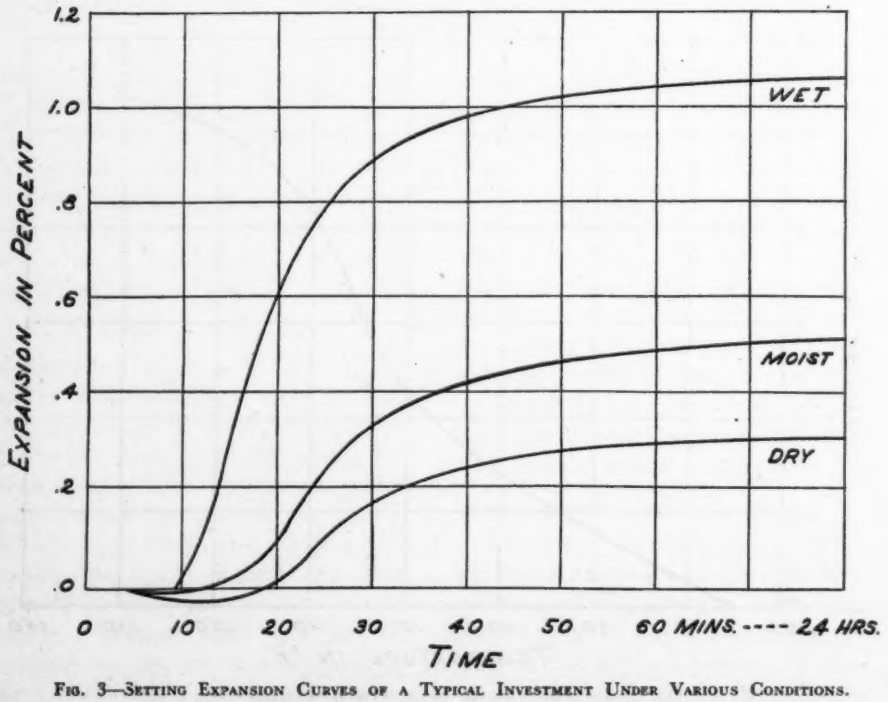


FIG. 3—SETTING EXPANSION CURVES OF A TYPICAL INVESTMENT UNDER VARIOUS CONDITIONS.

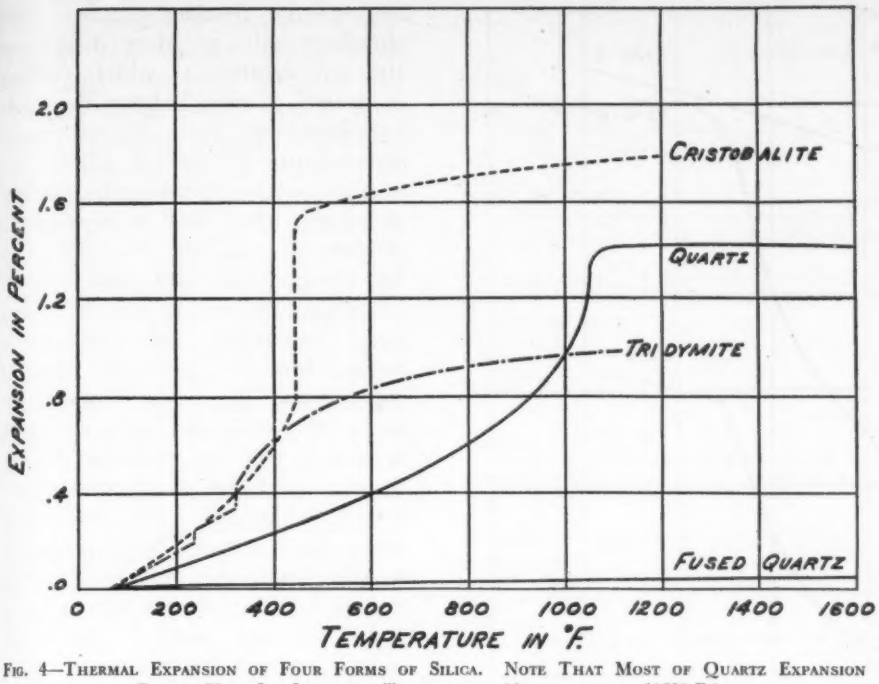


FIG. 4—THERMAL EXPANSION OF FOUR FORMS OF SILICA. NOTE THAT MOST OF QUARTZ EXPANSION OCCURS NEAR ITS INVERSION TEMPERATURE (APPROXIMATELY 1063° F.)

placing the investment therein. The curve marked "moist," Fig. 3, shows the effect of a single asbestos liner. A double thickness of asbestos will permit even greater infusion of moisture and will increase the expansion another 0.1 per cent. The curve marked "wet" shows the setting expansion for complete immersion under water 7 min. after investing. If placed under water sooner, there will be greater expansion.

There is thus quite a choice in setting expansion so that one may vary the expansion of the same investment merely by a choice of the moisture conditions during the setting. Rigid control in preparation of investments is necessary to insure reproducible expansion from time to time under the various possible conditions.

Thermal Expansion. It is fortunate that the heating of an investment mold to a dull red heat (1200 to 1300° F., 649 to 704° C.) serves three necessary purposes: (1) it dissipates or volatilizes the wax pattern and burns away any carbonaceous residues, (2) it provides a mold hot enough to prevent premature freezing of the casting alloy in this section, and (3) it expands the mold so as to help compensate for wax and metal shrinkages.

Investments consist essentially of silica and plaster. Figure 4 shows the thermal expansion of four forms of silica. It is to be noted that the form most universally used, namely, quartz or sand, has a thermal expansion of 1.5 per cent, and most of this occurs near its inversion temperature at approximately 1063° F. (573° C.). This inversion involves a crystal change from low quartz to high quartz. Cristobalite, another phase of silica, has an even greater expansion and occurs at a lower temperature, namely, approximately 450° F. (232° C.). Tridymite also has high expansion and inverts twice at an even lower temperature. Fused quartz has the lowest expansion of any commonly occurring material.

Plaster is unusual in that it shrinks tremendously upon heating. In fact, it shrinks about as much as silica expands. Gypsum is calcium sulphate with 21 per cent of chemically combined water. When heated to about 400° F. (204° C.), 15 per cent water is driven off and plaster of paris is formed. When plaster of paris is mixed with water, it takes up 15 per cent of water and returns to gypsum. Upon heating, set plaster (gypsum) again loses water and changes to plaster, or hemihydrate ($CaSO_4 \cdot \frac{1}{2} H_2O$). This changes to soluble anhydrite at about 500° F. (260° C.) and finally to dead-burned gypsum ($CaSO_4$) at 600 to 850° F. (315 to 455° C.). The latter change, and its accompanying shrinkage, causes cracking of plaster molds during heating and drying, and is the principal obstacle to the more widespread use of plaster molds for casting metal. It is to be noted in Fig. 5 that the thermal expansion of plaster of paris varies considerable depending upon the ratio of water to plaster of paris. Curve 1, Fig. 5, shows the expansion and contraction when using 49 parts water to 100 parts plaster, and curve 2 shows the same when using less water, namely 37 parts water per 100 parts of plaster. These curves are based on the use

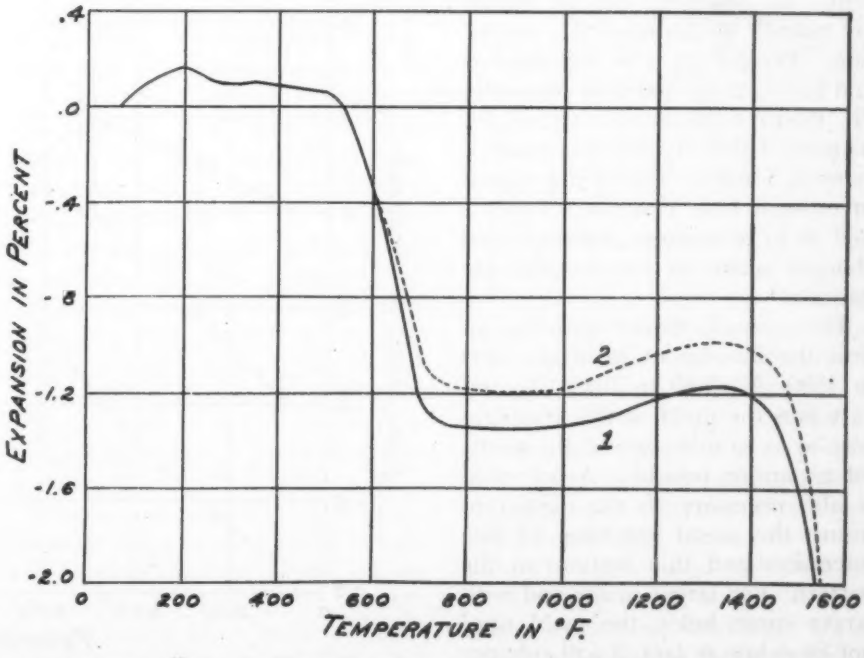


FIG. 5—THERMAL EXPANSION OF PLASTER OF PARIS. CURVE 1—49 PARTS WATER TO 100 PARTS PLASTER. CURVE 2—37 PARTS WATER TO 100 PARTS PLASTER.

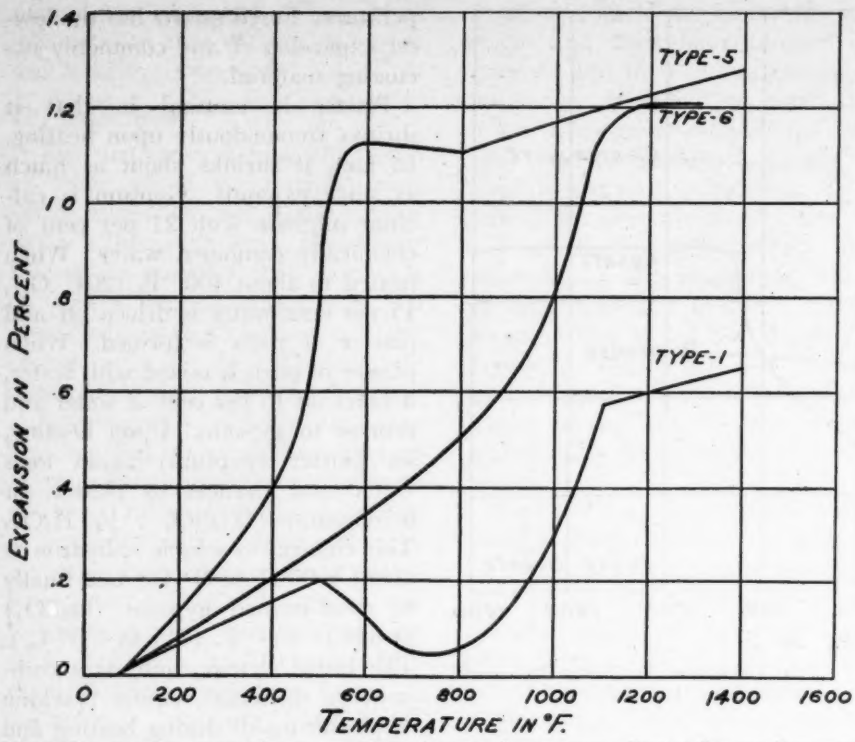


FIG. 6—THERMAL EXPANSION CURVES FOR THREE TYPICAL INVESTMENTS. CURVES ARE FOR INVESTMENT TYPES 1, 5 AND 6 OF APPENDIX II.

of a special form of plaster known as alpha gypsum.[21] This material has a normal pouring consistency of 40 parts of water to 100 parts of powder. Ordinary plaster of paris requires 60 parts of water to 100 parts of powder, and has an even greater shrinkage.

To overcome the tremendous shrinkage of plaster, investments contain a larger proportion of silica, 60 to 80 per cent, and a minimum proportion of plaster, 20 to 40 per cent. In addition, certain agents are added to improve the expansion. Typical types of investments and formulae are given in Appendix II. Figure 6 shows the thermal expansion of three typical investments, types 1, 5 and 6. Type 1 is a typical investment base material. Types 5 and 6 have various additions and changes made to increase the expansion.

It is usual dental practice to heat the investment to about 1200 to 1300° F. (649 to 704° C.) and cast into the mold at this temperature so as to make use of the greatest expansion possible. A hot mold is also necessary to the dentist to insure the metal reaching all fine interstices and thin sections of the pattern. For larger molds and with larger sprue holes, the mold need not be so hot, in fact, it will enhance quicker cooling of the metal if the mold is cooler. Curve 1, Fig. 7, shows the thermal expansion of Type 1 investment on heating, and curves 2 and 3 the shrinkage upon cooling. It is to be noted that, as the mold is cooled, it will shrink to a point much lower than that reached at the same temperature during the heating cycle. The shrinkage will vary, depending upon the temperature at which cooling is started. Curve 2 shows the cooling shrinkage from the maximum temperature of 1400° F. (760° C.), and the curve 3 shows the cooling shrinkage when held at a constant temperature of 500° F. (260° C.) for about 2 hr. and then cooled. Therefore, it is necessary to determine expansion and contraction values for the particular investment under the exact temperature and time conditions under which it is used in practice to insure having correct values for use in compensation calculations. The maximum temperature usually is that required to completely dissipate the pattern material. Dental castings almost invariably are made in molds at their maximum temperature to utilize the maximum expansion. Casting in cool molds is possible when necessitated by metallurgical considerations. However, cooling the mold invites cracking of the mold due to the added strain of a high negative coefficient of expansion.

(3) *Casting Alloys*

Types of Alloys Castable. At one time or another, practically all metals and alloys have been cast in investments with at least some de-

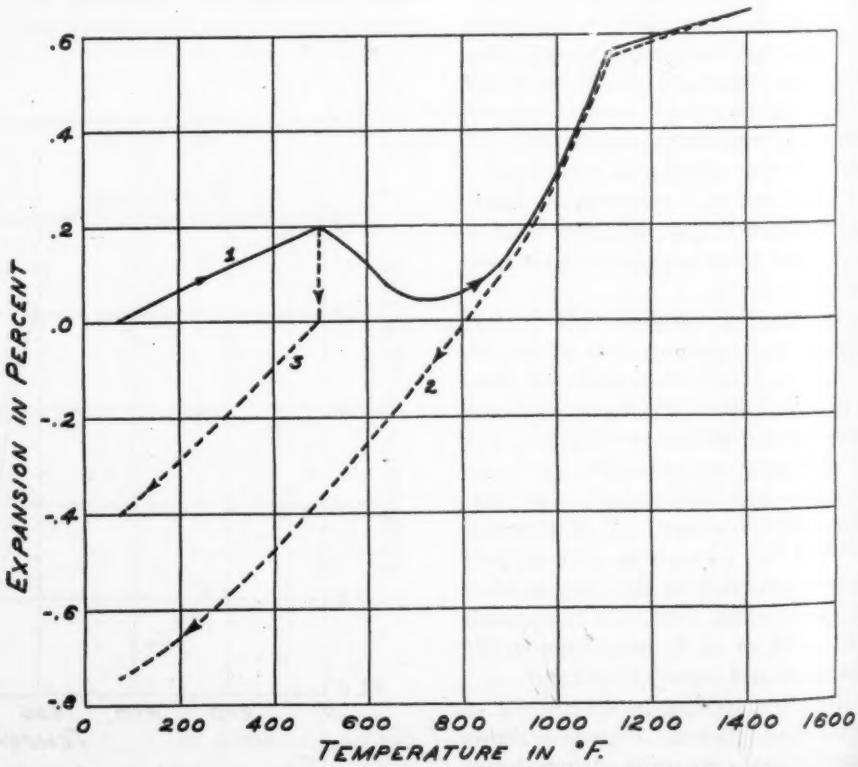


FIG. 7—THERMAL EXPANSION AND SHRINKAGE CURVES OF TYPE 1 INVESTMENT. CURVE 1—EXPANSION ON HEATING. CURVES 2 AND 3—SHRINKAGE ON COOLING FROM DIFFERENT TEMPERATURES.

gree of success. Aluminum casts well, as do zinc alloys. It is believed that magnesium also will cast successfully when proper care is exercised. However, the principal field of application is in copper-base alloys, stainless steels and chromium alloys. The casting of low-alloy and carbon steel is as yet impossible in plaster-containing investment, and not too successful in more refractory investments. However, this is the goal of all precision casters, and is looked forward to with optimism.

Many precision-cast brass parts were previously machined from free-turning yellow brass, tobin bronze, naval brass, and others available as extruded shapes or bar stock. It is necessary to match the standing specifications with alloys in the "as-cast" state. The physical properties of alloys cast in investment molds are approximately the same as sand cast. Brasses containing 58 to 65 per cent copper, 0.1 to 1.0 per cent aluminum and the remainder substantially zinc, can be cast with tensile strengths in excess of 50,000 psi. and elongation of over 20 per cent. Tensile strengths as high as 110,000 psi. and elongation of 10 to 40 per cent are possible with manganese bronzes. For specific requirements, aluminum bronzes and silicon bronzes can be cast successfully.

To date, alloys containing over 0.5 per cent lead and high in copper have not provided smooth surfaces. Further work in investments is expected to overcome this difficulty. This is true of investments containing plaster. Stainless alloys, such as cobalt-chromium-molybdenum and similar alloys of the "stellite" types, as well as stainless steel, are successfully cast in special investments, such as types 9 and 10 of Appendix II.

Nature of Casting Shrinkage. Alloys go through three decreases in volume during casting[6]:

(1) Contraction of liquid from casting temperature to freezing point.
(2) Contraction of alloy due to change of phase from liquid to solid at constant freezing temperature.
(3) Contraction of solid alloy from freezing point to room temperature.

Pure gold is used as an example because accurate contraction data

Table 1

COMPENSATION CALCULATIONS

		Per Cent
Dental		
(A) Shrinkages		
Wax pattern shrinkage (95 to 75° F.)		0.25
Casting shrinkage of gold		1.25
	Total	1.50
(B) Expansions		
Setting expansion of investment (Type 6)		0.30
Thermal expansion of investment (at 1200° F.)		1.20
	Total	1.50
Total shrinkages (1.50 per cent)=Total expansions (1.50 per cent)		
Precision Casting		
(A) Shrinkages		
Wax pattern shrinkage		1.00
Casting shrinkage of brass		1.80
	Total	2.80
(B) Expansions		
Setting expansion of investment		0.30
Thermal expansion of investment (at 1200° F.)		1.00
	Total	1.30

Shrinkages—expansions=2.8 per cent—1.3 per cent=1.5 per cent. Therefore, master patterns should be enlarged 1.5 per cent.

Total shrinkages (2.8 per cent)=total expansions (2.8 per cent).

are available, although data for item 1 have not been determined reliably. Item 2 is given as 1.46 per cent. Item 3 is 1.76 per cent. Under favorable conditions all of the contraction, except in the solid state, is compensated for by the addition of more liquid from the crucible. The contraction of pure gold in the solid state is 1.76 per cent, and of the alloy 90 per cent gold, 10 per cent copper is 1.62 per cent. The actual casting shrinkage of the latter is 1.25 per cent in investment molds, and does not vary appreciably due to changes in casting temperature, mold temperature or pressure.

This also is true of the aluminum-copper alloy containing 95 per cent aluminum, 5 per cent copper when cast in sand[6] where a casting shrinkage of 1.64 per cent was found. The contraction of pure aluminum from its freezing point to room temperature is 1.95 per cent by extrapolation of the values given in reference 12. The contraction of 95 per cent aluminum, 5 per cent copper alloy is known to be but slightly less than that of pure aluminum, so that the use of a value of 1.9 per cent is safe. Again, the casting shrinkage is lower than the normal shrinkage.

The contraction of brass from its freezing point is not easily found, but extrapolation of various curves from 600° C. (1112° F.) to the freezing point gives values of approximately 2.5 per cent for a 60 per cent copper—40 per cent zinc alloy. The casting shrinkage of this type alloy is ¼ in. per ft. (2.08 per cent) for sand castings, and a similar value is found in the investment process. Here again the casting shrinkage is less than normal shrinkage.

The difference between normal contraction and casting shrinkage may be due to one or more of the following[6]:

(1) There may be sufficient friction or interlocking of the first thin shell of alloy to solidify, to permit its being heated and stretched (it is still comparatively soft) by the bulk of the still molten metal in the center.
(2) Some of the alloy may cool and solidify before the metal in the crucible freezes and thus some of the cooling shrinkage is compensated for by new molten metal.

It is the author's belief that considerable work has yet to be done to learn more about this phenomenon. Some workers in the dental field have shown no difference in contraction due to difference in casting size or shape; in practice the dentist requires more expansion for larger multiple surface inlays. Many measurements made on larger precision castings (brass) show variations in actual shrinkage. It is not believed that this is due to variation in casting shrinkage of the alloy, but to other factors, the nature of which is still unexplainable.

As more data become available on castings of various sizes and shapes, and more is known on the effect of investment in resisting metal shrinkage, a more comprehensive understanding of this subject will be forthcoming.

Patterns

Master Pattern

The production of a precision casting begins with an actual piece of the desired shape and size, if it is in production, or a blueprint of a new part to be made. If a part is available, it often is most time saving to make a preliminary die and make test-castings. In this way, various methods of sprueing, etc., are tested and the best way determined. Most helpful is the opportunity to determine shrinkages and the necessary means and amount of compensation.

Obviously, on a new piece, the beginning is the blueprint. Here, as usual, consultation between customer and precision caster will produce the best and most economical results. Experience to date has shown that in most cases the object or part can be redesigned to give added features which were originally desired, but which had to be omitted for various practical reasons, such as limitations of coring in sand casting or costly machining operations.

Shrinkage Calculation. With a given design and specifications, shrinkages and expansions are calculated. Supposing, for example, that a certain dimension is given as 1.000 in., plus or minus 0.003 in. (Fig. 8 *A*). From practice, we have learned that our wax shrinks 1.0 per cent; i.e., it is adapted to a warm mold and upon cooling to room temperature it shrinks 1.0 per cent. A brass, containing essentially 65 per cent copper and 35 per cent zinc, is to be used which has a pattern-maker's shrinkage of 7/32 in. per ft., or 1.80 per cent. These shrinkages total (1.0 per cent and 1.80 per cent) 2.80 per cent.

Compensation Calculations. The chosen investment has a setting expansion of 0.3 per cent and a thermal expansion of 1.0 per cent at 1200° F. (649° C.), giving a total of 1.3 per cent. There still is a difference of (2.80 minus 1.3) 1.5 per cent (shrinkage). If a dentist were making the job and he needed but one casting, he would resort to placing the pattern in a warm investment or letting the investment set under water to achieve a hygroscopic expansion of 1.5 per cent. Since perhaps 10,000 pieces are needed, the foundryman's method of enlarging the pattern is the best resort. However, it is necessary to produce but one master, and it is well to make it accurate and smooth, as it will produce all of the patterns. A 1.5 per cent increase in pattern size is needed. Therefore, 0.015 in. is added to the 1.000 in. and produces a master pattern 1.015 in. in size. This usually can be held to a tolerance of 0.001 in., and often to plus or minus 0.0005 in. or better. These calculations are shown in Table 1.

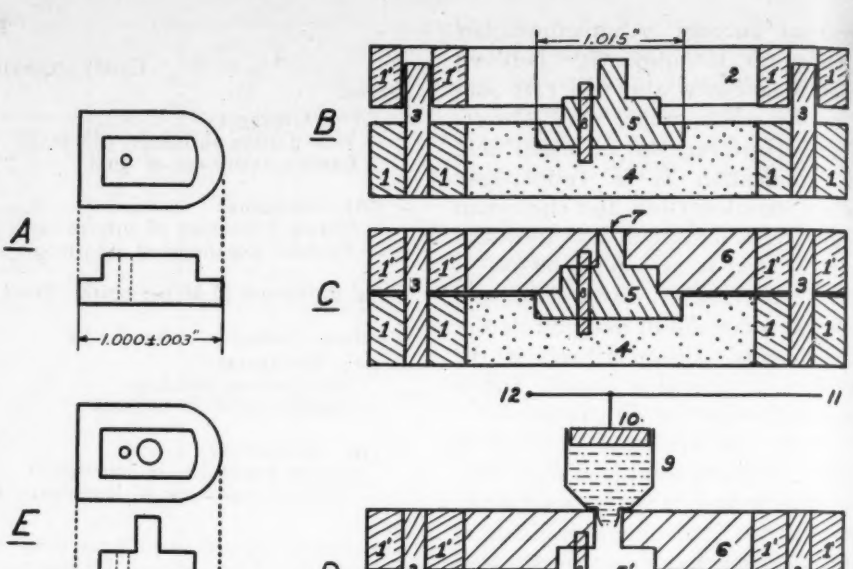


Fig. 8—Production of Metal Die and Wax Patterns. A—Views of Casting According to Blue Print. B and C—Cross Sections Showing Metal Die Construction. D—Cross Section Showing Die Assembled for Making Wax Pattern. E—Views of Finished Pattern. 1 and 1¹—Steel Matrix. 2—Rectangular Opening Cut in Steel. 3—Holding Pins. 4—Plastic Clay. 5—Master Pattern. 6—Fusible Metal Forming Upper Mold Half. 7—Entrance Sprue for Wax. 8—Pin Set in Die for Forming Hole in Pattern. 9—Wax Gun. 10—Wax Gun Piston. 11 and 12—Wax Gun Handle. 13—Fusible Metal Forming Lower Mold Half.

Metal Die

Alloy. The die needs only to resist molten wax, seldom over 200° F. (93° C.) and under pressures of several thousand psi. If the object is not too complicated, the die may be machined from steel, brass, or even aluminum or zinc, and all or part of it can be machined to size without need of a master. A steel die has shown no wear in the production of 107,000 patterns.

Where the design is complicated and a master is needed, it is necessary to resort to the use of low-melting alloys, such as 50 per cent bismuth, 32.2 per cent lead and 17.8 per cent tin, or 60 per cent tin and 40 per cent bismuth. These alloys have no shrinkage or expansion if properly balanced in composition. Bismuth expands on cooling, and if 40 to 50 per cent is used, the alloy as a whole will be neutral in casting shrinkage.

(Part 2 will appear in the October American Foundryman.*)*

Booklets Are Issued On Employee Relations

THE Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York, has prepared two booklets that are designed to help the employer with his personnel problems.

One booklet, "Recruiting Women Workers," deals with the need of recruiting women for industrial work. It shows the effort put forth by different firms to bring women into industry, and it points out the benefits that are open to women in war work.

The second booklet, "The Employee Counselor In Industry," sets forth the duties of the counselor (often termed coordinator or supervisor), and shows how personnel relations are improved through the efforts of these "trouble shooters" in the plant.

CASTINGS

One of Our Modern Conveniences

From the Consumers' Viewpoint

• This paper was presented before a session on Inspection of Castings, held during the 3d War Production Foundry Congress at Buffalo, N. Y. The session was sponsored by the A.F.A. Castings Inspection Committee, which was organized this past year to bring to A.F.A. members information on matters pertaining to the inspection of castings, which will benefit both the user and producer of foundry products.

Presented By
L. A. DANSE
General Motors Corp., Detroit

THE title which was assigned for this chat stated, "from the Consumers' Viewpoint," but this statement is hardly fair. This is particularly true when we consider that the great majority of consumers know little and care less about what goes into the equipment which makes their lives so much easier to live and so much fuller to enjoy. Therefore, the title is a misnomer.

The history of mankind is not old as compared to the story of the world, or that of our expanding universe, but: who stops to think of this? And, out of all the history of mankind, only this past century has disclosed the mounting progress in invention and development that is so marvelously enriching these present times. Yet, where is there among us one who regards this with appreciation? Or with anything else but the nonchalance of the sophisticate?

So What!

In short and plain English, what regard has the average user for the headaches that go to make up the things he so casually enjoys?

Fabricator Better Qualified

So, let us think with the fabricator, he who converts our castings into finished structures. From him let us ask the expression of evaluation derived from critical appraisal of our material.

Criticism Stimulates Correction

One of our substantial members said recently, with reference to critical appraisal, that "Our critics are our best friends." This is evidence that the intentions are good, the attitude is right, the efforts are conscientious. Given these premises, the results may be expected to speak for themselves, with credit to the producer, and by the same token, "He who cannot bear to be criticized, cannot afford not to be criticized."

From Tubal and Javan to Now

For many centuries we have developed from the days of Tubal Cain, that famed artificer in metals, and his brother Javan, that equally famed early foundryman. Progress has at times been halting and, on occasion, lacking. However, with the greater spiritual enlightment of the unfolding years has come mental freedom and, with it, physical advancement.

Excelsior Metallurgicus

To the patient researchers and careful experimenters in the science of metallurgy and the arts and crafts of working metals, we owe much gratitude. Without the materials resulting from their continued efforts, the designs and engineering which delight our senses and promote our comfort would be as impossible of accomplishment as the proverbial "Figs from Thistles."

One Source

Let us pause in our mad rush and thank God, who in his infinite wisdom has given men to reflect the intelligence which makes available all these better things.

Light

As we read in the Book, and in succeeding historical works, of the struggles of these men, we may know that without them and their discoveries, without what they have brought to light, we would be lacking much that is useful and comforting.

More Light

And, as we take stock of these very practical considerations in which you and I have mutual interest, let us appreciate that which merits it; let us evaluate everything we consider; and let us not spare the critique, for without such uncovering, how can we find our faults?

Industrial Interest

The interest which I personally share with you is because I have the honor to represent a corporation which is a large, widespread and far-flung industry. This company has, for the past 40 years or so, engaged in the production of automotive transportation; starting with passenger cars, going into trucks and busses, reaching out into the field of household mechanical and electrical equipment, taking in rail locomotives, marine power plants, aircraft power plants, aircraft and, of late, heavy combat vehicles, and military transport vehicles, together with a myriad of arms, ammunition, ordnance, and other military and naval materiel items.

Castings Important

In some of this equipment, castings figure heavily—or should I rather say seriously, or importantly, because they are major componants in much of the car, truck and locomotive construction; because they provide the needed physical characteristics, together with a certain special facility of design and construc-

tion; and because all this is balanced against weight and cost.

Characteristics vs. Cost

Here we have the crux of the situation: The balance of physical characteristics against cost.

Development vs. Limitation

And, likewise, in this balance of utility against cost, we will find the answer as to whether the field for castings will broaden in postwar automotive transport; or whether car, bus, truck and railroad rolling stock design and construction will follow aircraft technique.

Light Metal Competition

The war-time demand for combat and transport aircraft has caused a tremendous expansion in the facilities for producing the light metals and for fabricating parts made from light metals. Postwar, these facilities will be far in excess of the military and naval demands for the materials now going into aircraft. There will be a great increase in the production of commercial aircraft, but not sufficient to prevent the intrusion into the automotive field of a considerable tonnage of light metals available for use in products heretofore fabricated of ferrous metals.

Cost a Question

Few of us today are prepared to say at what cost figures the aluminum and magnesium alloys will be thrown into competition with ferrous metals.

New Horizon

So, we are sure to be confronted, after hostilities cease, with an unprecedented competitive condition. Magnesium will compete with aluminum . . . aluminum will compete with steel . . . and steel stampings will compete with steel forgings, so that iron and steel castings will be forced to develop new possibilities not now foreseen.

Facility Utilization Will Force Development

These war times have forced on us one unhealthy condition: The expansion of plant facilities has been on a scale which, while fully warranted by military and naval needs, will in postwar days force us to seek new markets, to find new fields of use, to develop outlets through redesign of old products and the creation of new ones.

Survival of the Fittest

This re-conversion to peace time pursuits will cause a competitive condition of the utmost intensity, pitiless in its elimination of those not prepared to weather the struggle for survival.

Not Without Benefits

But the war conditions, while in that way troublesome, have included a few markedly improved practices which can be used to advantage to promote peace-time production, if we are alert to the possibilities. By this is meant not only the better sand conditioning and other casting production equipment in the foundries, but better control equipment, better heat treating, better repair equipment, better testing equipment, and last, but by no means least, far better knowledge of materials, their characteristics, their handling and their resistance to service conditions.

Quality Questionable

Gray iron casting producers have protested the demands of their customers for improved soundness, besides better dimensional accuracy. While all due allowances should be made for war conditions, the fact remains that whatever be the technical causes, the fabricator has had much difficulty getting accurate sized, pressure tight castings of specification hardness, without chilled corners and edges or hard spots due to segregations, undiffused additions or oxidized iron. However, we are learning that gray iron can be made sound and we are making it sound.

Quality Suspect

Producers of malleable iron castings of both blackheart and pearlitic types have been unhappy because of the insistance of the fabricators that material of this type should be sound and heat treated true-to-type —the blackheart without heavy hard pearlitic rim and the pearlitic without either mottling or white areas. This lesson is also being learned, that we can make sound true-to-type malleable castings.

Quality Essential

Aluminum casting producers have bewailed the insistance of some of the project engineers of the aircraft engine industry, who have demanded sound castings. Lack of soundness delayed the development of increased power output of the engines to a considerable extent. The urgency of military aircraft needs spurred the engineers to infuse their own enthusiasm into their foundry sources; so we have learned that aluminum castings can be made sound and we are making them sound.

Quality Tangible

We have heard plaints from steel casting producers, which to some of us appeared off tune, such as those made in some volume to the effect that nobody expected steel castings to be sound and they would not be any better if they were. Certainly our thinking has improved since then, and our standards of steel castings production have been lifted accordingly. We have learned that steel castings can be made sound and we are making them sound.

Quality Controls

We have adopted X-ray testing to promote development of gating and risering. We have improved sand control and venting, along with gates and risers. So, now we can assure elimination of such unsoundness as shrinks, hot tears, sand holes and blows, to an extent equal to freedom from surface evidences of poor workmanship. We have overwhelming proof that such sound steel castings perform as much better than unsound ones, as we might be entitled to expect from the elimination of any other notches, stress raisers, discontinuities, or voids.

Quality Standards

We have been asked the question, "What is the elastic modulus of a bubble?" And we have chased the voids out of the castings, so the question no longer embarrasses us.

Technology

Improvement in sand conditioning is the order of the day. Better melting conditions are becoming infectious. Burden make-up and alloying practice are being formulated. Delving into hardenability and response to heat-treatment is commonplace. We are increasing the technical staffs of the foundries, and we have enlisted the best minds and laboratories in the land to facilitate finding the remedies for troubles. We have available the advice and consultation of those who are capable of leading us across the red sea of fear and out of doubt.

Proof of Treatment and Composition

Advantage is being taken of testing methods long disused and forgotten, but now re-recognized as efficacious and providing still further assurance of soundness and quality.

Wider Outlook

The diligent seekers for facts have broken down mental barriers and crossed new frontiers in composition and effect of constituent elements. This applies also to the physical chemistry of the making and handling of the melt and its tapping and pouring.

Uplift from War's Demands

Both the art and the science of making castings have received tremendous impetus from war requirements, and this has had the result of providing us ready to hand with much, if not all, that we need to start us out into enlarged usefulness in the times following cessation of hostilities.

The Map Is Not the Journey

But this has only shown us the way. We must ourselves walk in the way. "Nothing without effort." And, "Where there is no vision, the people perish."

Trustworthy

This brings us to the high point of our discussion: Where we realize our awakening and can confidently look forward to the future, when the fabricator can expect and trust that he will be provided with a product of definite quality at a cost which ensures economy. We must prove up to that expectation and worthy of that trust.

Progress Will Not Wait

If you please, I like the new term "Imagineering." It has an exhilarating and an accelerating effect on thought. We must utilize forward vision and keen out-of-the-rut planning, so as to provide finer and better products and so keep pace with that inexorable progress which Shakespeare, the immortal bard, describes when he says,

"There is a tide in the affairs of men,
Which, taken at the flood, leads on to fortune;
Omitted, all the voyage of their life
Is bound in shallows and in miseries."

Booklet of Rules For Crane Operation

THE Whiting Corporation, Harvey, Ill., in the interest of safety, has issued a 25-page booklet covering rules for safe operation of overhead traveling cranes.

The booklet emphasizes six general rules for the safe operation of cranes, as follows: "When operating a crane be sure you . . .

1. Are authorized to do so.

2. Operate your crane safely at all times. If you are in doubt as to safety, refuse to handle load until safety is assured.

3. Inspect your crane at beginning of each shift. Be sure limit switches, brakes, circuit breakers, and all other safety devices are in good working order.

4. Take signals only from the one man (hooker-on) who is supervising the lift, except where it is apparent that to do so would result in an accident.

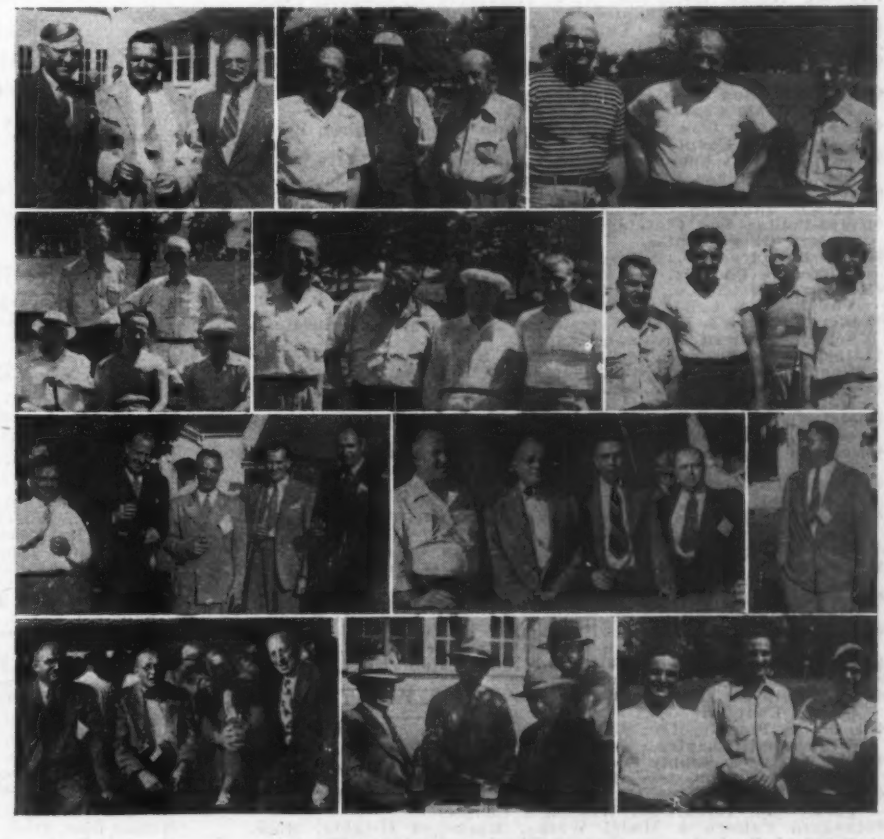
5. Place the trolley directly over the load before starting the hoist, to avoid swinging the load as the lift is started.

6. Avoid carrying loads over workmen. Use your crane signals to warn them of your movement."

I. B. F. Members Hear Exchange Paper

REPORTS indicate that M. J. Gregory's exchange paper, "Wartime Calls on Women to Make Aluminum Air-Cooled Cylinder Heads," which was presented before the 1944 meeting of the Institute of British Foundrymen, was well received. The paper, which was illustrated by motion pictures, provoked a lively discussion period, conducted by J. J. Sheehan, Coneygre Foundry Ltd., Tipton, Staffs, who presented the paper at the 41 annual conference of the I.B.F., held in Manchester, England.

The exchange technical papers for the respective meetings of the A.F.A. and I.B.F. annual meetings has been an unbroken series since 1920.



(Photos courtesy John Bing, A. P. Green Fire Brick Co.)

A "handful" of the 800 members and guests attending the 13th annual golf outing sponsored by the Wisconsin Chapter, July 21, at the Ozaukee Country Club, Milwaukee. Needless to say, a good time was had by all.

NEW ASSOCIATION MEMBERS

July 16 to August 15, 1944

• All things considered, including vacations and summer heat, the A.F.A. continues to grow, and records of past achievement are being shattered. The period, July 16 to August 15, showed a total of 140 new members—68 new members were recorded in the same period last year! In addition, there are two new sustaining members and four conversions from company to sustaining members. Yes, the foundry industry, through the American Foundrymen's Association, seems to be destined for a prominent place in the postwar "sun."

Conversions from Company to Sustaining Membership
(Erroneously reported as Company Members in August Issue)

†Arcade Manufacturing Co., Freeport, Ill. (L. L. Munn)—No. Illinois-So. Wisconsin Chapter.
†Bendix Products Division, South Bend, Ind. (Geo. E. Stoll, Asst. Gen. Mgr.)—Michiana Chapter.
†Bowler Foundry Co., Cleveland. (J. H. Bruce, Pres.)—Northeastern Ohio Chapter.
†Brillion Iron Works, Inc., Brillion, Wis. (R. D. Peters, Gen. Mgr.)—Wisconsin Chapter.
†H. W. Butterworth & Sons Co., Philadelphia. (John H. S. Spencer, Mgr.)—Philadelphia Chapter.
†Carbon Malleable Casting Co., Lancaster, Pa. (Paul M. Hufford, Sec.)—Philadelphia Chapter.
†Edwin S. Carman, Inc., Cleveland (Edwin S. Carman, Pres.)—Northeastern Ohio Chapter.
†Chicago Retort & Fire Brick Co., Chicago (A. H. Taylor, Vice-Pres.)—Chicago Chapter.
†Clearfield Machine Co., Clearfield, Pa. (P. B. Reed, Pres.)—Outside of Chapter.
†L. S. Cohen & Co., Chicago. (Harold A. Berger, Sales Rep.)—Chicago Chapter.
†Davenport Machine & Foundry Co., Davenport, Iowa (Chas. F. Scherer, Vice-Pres. & Gen. Mgr.)—Quad-City Chapter.
†Dick Bros., Inc., Reading, Pa. (Charles K. Dick, Pres. & Treas.)—Philadelphia Chapter.
†E. I. du Pont de Nemours & Co., Wilmington, Del. (W. R. Heald, Mgr.)—Philadelphia Chapter.
†Stanley G. Flagg & Co., Inc., Philadelphia (D. A. Jones, Treas.)—Philadelphia Chapter.
†Gleason Works, Rochester, N. Y. (Lawrence C. Gleason, Fdry. Engr.)—Rochester Chapter.
†Greenlee Foundry Co., Chicago (Chas. B. Magrath, Pres.)—Chicago Chapter.
†Hobart Manufacturing Co., Troy, Ohio (W. H. Hartley, Factory Mgr.)—Outside of Chapter.
†E. F. Houghton & Co., Philadelphia (D. C. Miner, Adv. Mgr.)—Philadelphia Chapter.
†Iowa Malleable Iron Co., Fairfield, Iowa (W. V. Hughes, Pres.)—Quad-City Chapter.
†Josam Products Foundry Co., Michigan City, Ind. (J. H. Miller, Supt.)—Michiana Chapter.
†Keokuk Electro-Metals Co., Keokuk, Iowa (G. L. Weissenburger, Pres.)—Quad-City Chapter.
†Kindt-Collins Co., Cleveland (Ernest T. Kindt, Pres.)—Northeastern Ohio Chapter.
†Kirsh Foundry, Inc., Beaver Dam, Wis. (H. L. Kirsh, Pres.)—Wisconsin Chapter.
†Kuhlman Electric Co., Bay City, Mich. (Albert E. Rhoads, Exec. Vice-Pres. & Gen. Mgr.)—Detroit Chapter.
†Lakey Foundry & Machine Co., Muskegon, Mich. (Geo. Spoelma, Sec'y)—Western Michigan Chapter.
†Lithaloys Corp., New York City (Dr. H. Osborg, Vice-Pres. & Gen. Mgr.)—Metropolitan Chapter.
†Meehanite Metal Corp., New Rochelle, N. Y. (Oliver Smalley)—Metropolitan Chapter.
†Metal & Alloy Specialties Co., Inc., Buffalo, N. Y. (T. S. Hemenway, Pres.)—Western New York Chapter.
†Michigan Malleable Iron Co., Detroit (G. M. Harper, Treas.)—Detroit Chapter.
†National Foundry & Machine Co., St. Louis (Wm. L. Heckman, Pres.)—St. Louis Chapter.
†National Smelting Co., Cleveland (Walter M. Weil, Treas.)—Northeastern Ohio Chapter.
†Ohio Foundry Co., Cleveland—Northeastern Ohio Chapter.
†Phoenix Iron Works Co., Oakland, Calif. (S. D. Russell, Pres.)—Northern California Chapter.
†Wm. E. Pratt Mfg. Co., Joliet, Ill. (F. E. Clark, Pres.)—Chicago Chapter.
†Pyle Pattern & Mfg. Co., Muskegon Heights, Mich. (Adam Pyle, Jr., Sec'y)—Western Michigan Chapter.
†Reliance Regulator Corp., Alhambra, Calif. (Robert Gregg, Fdry. Mgr.)—Southern California Chapter.
†Frank Roth Co., New York City (Frank Roth, Partner)—Metropolitan Chapter.
†St. Marys Foundry Co., St. Marys, Ohio (Chas. E. Dine, Pres.)—Cincinnati Chapter.
†Smith Facing & Supply Co., Cleveland (F. Ray Fleig, Vice-Pres. & Mgr.)—Northeastern Ohio Chapter.
†Smith Oil & Refining Co., Rockford, Ill. (O. S. Smith, Vice-Pres.)—No. Illinois-So. Wisconsin Chapter.
†Standard Pattern & Model Works, Muskegon Heights, Mich. (Clifford D. Anderson, Owner)—Western Michigan Chapter.
†Sterling Wheelbarrow Co., West Allis, Wis. (I. R. Smith, Pres.)—Wisconsin Chapter.
†Swayne-Robinson & Co., Richmond, Ind. (C. K. Robinson, Vice-Pres. & Gen. Mgr.)—Michiana Chapter.
†U. S. Pipe & Foundry Co., Burlington, N. J. (R. K. Haughton, Vice-Pres.)—Philadelphia Chapter.

New Sustaining Members

†The Dow Chemical Co. (Maude Ellwood, Librarian) Midland, Mich.—Detroit Chapter.
†Lauhoff Grain Co. (Howard J. Lauhoff, Partner) Danville, Ill.—Chicago Chapter.

Conversions from Company to Sustaining Membership

†American Magnesium Corp., Buffalo, N. Y.—Western New York Chapter.
†Commerce Pattern Foundry & Machine Co., Detroit (E. J. Rousseau, Pres.)—Detroit Chapter.
†Delta-Star Electric Co., Chicago (H. A. Tracy, Asst. Sec.-Treas.)—Chicago Chapter.
†Jewell Alloy & Malleable Co., Inc., Buffalo, N. Y. (R. T. Rycroft, Pres.)—Western New York Chapter.

BIRMINGHAM CHAPTER

A. B. Addington, Personnel Dir., McWane Cast Iron Pipe Co., Birmingham.
Clarence Bailey, Foundry, McWane Cast Iron Pipe Co., Birmingham.
Fred C. Barbour, Chemist, McWane Cast Iron Pipe Co., Birmingham.
W. D. Briggs, Special Foundry, McWane Cast Iron Pipe Co., Birmingham.
Frank Kapp, Foundry, McWane Cast Iron Pipe Co., Birmingham.
A. R. Marcus, Foundry, McWane Cast Iron Pipe Co., Birmingham.
C. J. Pruet, Time Study, McWane Cast Iron Pipe Co., Birmingham.
Charles M. Strickland, Melting Dept., McWane Cast Iron Pipe Co., Birmingham.

CANTON DISTRICT CHAPTER

*The Canton Pattern & Mfg. Co. (Theo. M. Dubs, Pres.) Canton 1, Ohio.
Anthony Rose, Core Room Foreman, Union Metal Mfg. Co., Canton.
Charles W. Traynor, Foundry Foreman, Union Metal Mfg. Co., Canton.

CENTRAL INDIANA CHAPTER

John Miller, Job Floor Foreman, The Perfect Circle Co., New Castle, Indiana.

CENTRAL NEW YORK CHAPTER

*Reddin Iron Works, Inc., Syracuse, N. Y. (D. J. Seubert, Pres.)
Fred H. Stebbins, Consulting Engineer, Worcester, Otsego County, N. Y.

CHESAPEAKE CHAPTER

Joseph A. Creevy, Lieutenant, U. S. Navy, Annapolis, Md.
Frederick G. Snowden, Leadingman Molder, Norfolk Navy Yard, Portsmouth, Va.

CHICAGO CHAPTER

Sam Furticella, Asst. Core Room Foreman, Continental Foundry & Machine Co., East Chicago, Ind.
*Garden City Foundry Co., Chicago (Joseph V. Shanley, Pres.).
Achilles Gatto, Pattern Checker, Continental Foundry & Machine Co., East Chicago.
J. A. Hogan, Supt., American Brake Shoe Co., Chicago.
*Robt. Holmes & Bros., Inc., Danville, Ill. (B. J. Kelly, Fdry. Supv.).
W. L. Julian, National Carbon Co., Inc., Chicago.
Franklin D. Lauer, Time Study Supv., Continental Foundry & Machine Co., East Chicago.
Clyde Lewis, Continental Foundry & Machine Co., East Chicago.
Jay P. Lewis, Foreman, Continental Foundry & Machine Co., East Chicago.
H. Servatius, Supt., Robt. Holmes & Bros., Inc., Danville, Ill.

CINCINNATI DISTRICT CHAPTER

Worley P. Albaugh, Service Met., Miller & Co., Cincinnati.
William Dine, Prod. Mgr., The St. Marys Foundry Co., St. Marys, Ohio.
Harry J. Hanlon, Foundry Engineer, Wright Aeronautical Corp., Lockland, Ohio.
R. C. Hinman, Safety Director, Reynolds Metals Co., Louisville, Ky.
Library, University of Cincinnati, Cincinnati.

* Company Member.
† Sustaining Members.

DETROIT CHAPTER

Eugene L. Buchman, Div. Foreman, Fdry. Exp., Ford Motor Co., Dearborn, Mich.
Alvin S. Lundy, Chief Engr., Claude B. Schneible Co., Detroit.
William J. Ryan, Supt., Griffin Wheel Co., Detroit.
Eric Tysklind, Student, University of Michigan, Ann Arbor, Mich.
Bacon Pooi-Kan Yeung, Student, University of Michigan, Ann Arbor.

DETROIT CHAPTER—SAGINAW VALLEY GROUP

***Bridgeport Core Sand Co., Saginaw, Mich. (Fred P. Langschwager, Co-Partner).**
B. G. Harr, Met., Dow Chemical Co., Bay City, Mich.
A. J. Heindel, Sales Engineer, U. S. Graphite Co., Saginaw, Mich.
Arthur H. Karpicke, Jr., Met., Saginaw Malleable Iron Co., Saginaw.
Fred Klemack, Foreman, Chevrolet Grey Iron Foundry, Saginaw.
Harold J. Lange, Fdry. Supt., Dow Chemical Co., Bay City.
John Lapin, Fdry. Engr., Dow Chemical Co., Bay City.
Erwin C. Moessner, Chemist, U. S. Graphite Co., Saginaw.
Peder Edward Moluf, Fdry. Engr., Dow Chemical Co., Bay City.
Forrest R. Old, Peninsular Grinding Wheel Co., Detroit.
Wm. B. Pryer, Draftsman, Saginaw Malleable Iron Co., Saginaw.
Gerald J. Quinnan, Foundry Dept. Supt., Chevrolet Grey Iron Foundry, Saginaw.
Fay A. Smith, Foreman, Chevrolet Grey Iron Foundry, Saginaw.
Leon F. Watson, Foreman, Chevrolet Grey Iron Foundry, Saginaw.

EASTERN CANADA & NEWFOUNDLAND CHAPTER

Sidney Garber, Heat Treater, Hull Iron & Steel Co., Hull, Quebec.
***Lunenburg Foundry Co., Ltd. Lunenburg, Nova Scotia (A. W. Schwartz, Vice-Pres.).**
Ray Schwarts, Foundry Foreman, Lunenburg Foundry Co., Ltd., Lunenburg, N. S.
D. E. Young, Manager, Lunenburg Foundry Co., Ltd., Lunenburg, N. S.

METROPOLITAN CHAPTER

David Basch, Consultant, General Electric Co., Schenectady, N. Y.
Technical Service Dept., Corn Products Refining Co., New York City.
Franklyn Vanderveer, Met., Sperry Gyroscope Co., Lake Success, L. I., New York.

MICHIANA CHAPTER

Joseph F. Banach, Patt. Shop Foreman, Oliver Farm Equipment Co., South Bend, Ind.
Joseph S. Goncher, Melting Foreman, Oliver Farm Equipment Co., South Bend.
Raymond D. Gregory, Genl. Foreman, Clark Equipment Co., Buchanan, Michigan.
Fred Hall, Foreman, Clark Equipment Co., Buchanan.

NORTHEASTERN OHIO CHAPTER

Charles J. Clinton, Genl. Foreman, National Aluminum Cylinder Head Co., Cleveland.
Claro L. Fizer, National Aluminum Cylinder Head Co., Cleveland.
Charles J. Jelinek, National Malleable & Steel Castings Co., Cleveland.
A. E. Keskulla, Met., Auminum Co. of America, Cleveland.
Frank P. Malia, Tool Engineer, National Aluminum Cylinder Head Co., Cleveland.
***The Millwood Sand Co., Zanesville, Ohio (E. C. Sawyer, Service Engineer).**
Lou Mora, Engineer, National Aluminum Cylinder Head Co., Cleveland.
Wm. J. Reagan, Research Met., Copperweld Steel Co., Warren, Ohio.

NORTHERN CALIFORNIA CHAPTER

William C. Gruver, Service Engineer, Independent Pneumatic Tool Co., San Francisco.

NO. ILLINOIS & SO. WISCONSIN CHAPTER

***Burgess-Parr Co., Freeport, Ill. (Thomas E. Johnson, Plant Engineer).**

ONTARIO CHAPTER

F. P. Shanahan, Sales Dept., Shanahan's Limited, Vancouver, B. C., Canada.

PHILADELPHIA CHAPTER

Harry Matthew Eger, Sand Tech., Dodge Steel Co., Philadelphia.
Frankford Arsenal, Philadelphia.

QUAD-CITY CHAPTER

Woollard Chase Bullington, Inspector, Ordnance Steel Foundry Co., Bettendorf, Iowa.
E. P. Closen, Genl. Foreman, Deere & Mansur Works, Deere & Co., Moline, Ill.
John A. Crumley, The Union Malleable Iron Co. of Deere & Co., Moline, Ill.
***Galva Foundry Co., Galva, Ill. (Fred C. Helden, Pres.).**
L. A. Hagney, Secretary, Galva Foundry Co., Galva, Ill.
John P. Ward, The Union Malleable Iron Co. of Deere & Co., Moline, Illinois.

ROCHESTER CHAPTER

Thomas S. Busack, Met., Symington-Gould Corp., Rochester, N. Y.
Robert J. Raudebaugh, Assst Prof. of Met. Engrg., U. of Rochester, Rochester, N. Y.

ST. LOUIS DISTRICT CHAPTER

Hardin E. Markwell, Foundry Foreman, A. B. Chance Co., Centralia, Mo.
Western Cartridge Co., East Alton, Ill.

SOUTHERN CALIFORNIA CHAPTER

Edward J. Carroll, Foreman Squeezer Dept., Kinney Iron Works, Los Angeles.
Fred A. Moore, Pattern Maker, Precision Pattern & Model Shop, Los Angeles.
Harold G. Olson, Core Room Foreman, Aluminum Co. of America, Vernon, Calif.
Benj. L. Smith, Asst. Foreman, Aluminum Co. of America, Vernon, Calif.

TEXAS CHAPTER

***Cook Heat Treating Co. of Texas, Houston 11, Texas (Carl S. Cook, Partner).**
S. W. House, Furnace Supt., Texas Steel Co., Fort Worth, Texas.
Thurman Killman, Genl. Supt., Texas Steel Co., Fort Worth, Texas.
Gerald E. Smith, Fdry. Supt., Texas Steel Co., Fort Worth, Texas.
***Texas Steel Co., Fort Worth, Texas (Philip Hawkins, Sec.-Treas.).**

TWIN-CITY CHAPTER

H. Brushafer, American Brake Co., Brake Shoe & Castings Div., Minneapolis.

WESTERN MICHIGAN CHAPTER

Russell Worthington Bebber, Ind. Engr., Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich.
Carl Cornelius, Foundry Foreman, Cadillac Malleable Iron Co., Cadillac, Michigan.
Guy Curtis, Foundry Foreman, Cadillac Malleable Iron Co., Cadillac, Michigan.
Arthur Harn, Supt., Cadillac Malleable Iron Co., Cadillac, Mich.
Wm. Herweyer, Annealing Foreman, Cadillac Malleable Iron Co., Cadillac, Mich.
Frank Huffman, Pattern Foreman, Cadillac Malleable Iron Co., Cadillac, Michigan.
Cyril Meek, Chief Time Clerk, Cadillac Malleable Iron Co., Cadillac, Michigan.
Fred Meyerhofer, Genl. Foreman, Cadillac Malleable Iron Co., Cadillac, Michigan.
Forrest Oliver, Chemist, Cadillac Malleable Iron Co., Cadillac, Mich.
James Pappin, Personnel Mgr., Cadillac Malleable Iron Co., Cadillac.
Edward Price, Engineer, Cadillac Malleable Iron Co., Cadillac.
Frank Schmidt, Core Room Foreman, Cadillac Malleable Iron Co., Cadillac.
Elmo Sims, Finishing Dept. Foreman, Cadillac Malleable Iron Co., Cadillac.
Fern VanVolkinburg, Grinding Foreman, Cadillac Malleable Iron Co., Cadillac.

WESTERN NEW YORK CHAPTER

Louis Avino, Shipping Clerk, Jewell Alloy & Malleable Co., Buffalo, N. Y.
Harry Bessy, Foreman, Otis Elevator Co., Buffalo.
Alphonse A. Boisvert, Foundry Foreman, Otis Elevator Co., Buffalo.
Jack H. Bredbenner, Inspector, Otis Elevator Co., Buffalo.
Thomas Gacek, Cleaning Room Foreman, Otis Elevator Co., Buffalo.
Joseph Georgal, Sand Foreman, Otis Elevator Co., Buffalo.
John W. Greenan, Chief Melter, Otis Elevator Co., Buffalo.
Joseph Hajek, Genl. Foreman, Otis Elevator Co., Buffalo.
C. Wiliam Halst, Dispatcher, Otis Elevator Co., Buffalo.
G. P. Jausz, Production, Otis Elevator Co., Buffalo.
Lawrence C. Marx, Pattern Checker, Otis Elevator Co., Buffalo.
Casper Molterno, Refractory Foreman, Otis Elevator Co., Buffalo.
Frank Nowicki, Core Foreman, Otis Elevator Co., Buffalo.
Ralph T. Rycroft, Jr., Met., Jewell Alloy & Malleable Co., Buffalo.
Arthur Scott, Foreman, Otis Elevator Co., Buffalo.
Edgar Simes, Fdry. Supt., Otis Elevator Co., Buffalo.
W. F. Witzel, Material Supv., Otis Elevator Co., Buffalo.

WISCONSIN CHAPTER

Alexander Liberhi, Iron Distributor, Allis-Chalmers Mfg. Co., Milwaukee.
Ernest E. Sutter, Pattern Checker, Allis-Chalmers Mfg. Co., Milwaukee.

OUTSIDE OF CHAPTER

Juan J. Amaya, Jr., Mexico D. F., Mexico.
A. J. Attwood, A. Goninan & Co., Ltd., Broadmeadow, Newcastle, Australia.
E. H. Beckman, Manager, Provo, Utah.
***Robert Bryce & Co., Ltd., Melbourne, Victoria, Australia (E. Marschner, Mgr. Engrg. Dept.).**
***Continental Foundry & Machine Co., Wheeling Works, Wheeling, W. Va. (D. Wyman).**
***EFG Engineering Works, Inc., Seattle, Wash. (K. M. Ohlander, V. P. & G. M.).**
F. S. Grimwade, Grimwade Castings Pty. Ltd., Port Melbourne, Australia.
James Ward Johnston, Chief Molder, U. S. Navy.
***T. Main & Sons, Ltd., No. Richmond, Victoria, Australia (Wm. T. Main).**
Kenneth E. Rose, Res. Engineer, Battelle Memorial Institute, Columbus, Ohio.
***Russell Mfg. Co. Pty., Ltd., Richmond, Victoria, Australia (L. G. Russell).**
***Seattle Brass Co., Seattle, Wash. (Wm. Pigott).**
Superintendent, Storehouses & Oil Handling Plants, The Panama Canal, Balboa Canal Zone.

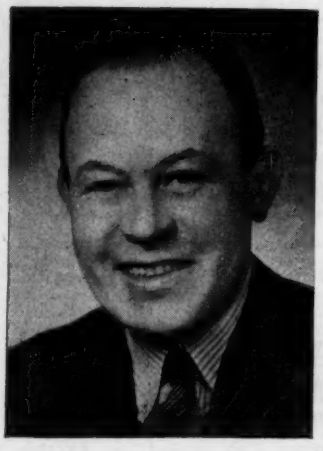
CHAPTER OFFICERS

A. H. Lankford
Wooster Products Co.
Wooster, Ohio
Vice-Chairman
Canton District Chapter

Harold H. Lurie
Cummins Engine Co.
Columbus, Ind.
Chairman
Central Indiana Chapter

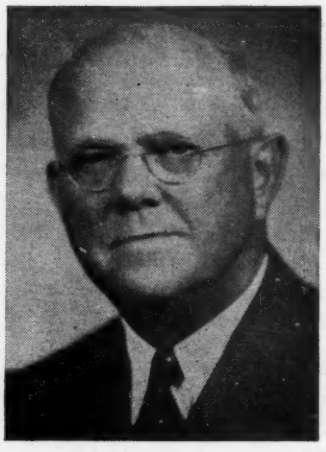
Robert Latham
Bethlehem Steel Co.
Bethlehem, Pa.
Chairman
Philadelphia Chapter

R. F. Lincoln
Russel F. Lincoln Co.
Lakewood, Ohio
Chairman
Northeastern Ohio Chapter



Ralph C. Noah
San Francisco Iron Foundry
San Francisco
President
Northern California Chapter

Thomas Bellsnyder
Jefferson Foundry Co.
Birmingham
Director
Birmingham District Chapter



A. M. Fulton
Northern Malleable Iron Co.
St. Paul
Chairman
Twin City Chapter

T. D. Parker
Climax Molybdenum Co.
New York
Chairman
Metropolitan Chapter

Howard F. Taylor
Naval Research Laboratory
Anacostia, D. C.
Vice-Chairman
Chesapeake Chapter

R. T. Robertson
International Harvester Co. of
Canada Ltd., Hamilton, Ontario
Chairman
Ontario Chapter

E. E. Hook
Dayton Oil Co.
Syracuse, N. Y.
Vice-Chairman
Central New York Chapter

W. D. Bailey, Jr.
Westlectric Castings, Inc.
Los Angeles
President
Southern California Chapter

1944-45 SEASON

Chapter Directory

Birmingham District Chapter

(Established 1936)

Chairman—J. T. Gilbert, Stockham Pipe Fittings Co., Birmingham.
Vice-Chairman—J. F. Wakeland, McWane Cast Iron Pipe Co., Birmingham.
Secretary-Treasurer—F. K. Brown, Adams, Rowe & Norman, Inc., Birmingham.
Directors—W. Carson Adams, W. Carson Adams, Birmingham.
Thos. Bellsnyder, Jefferson Foundry Co., Birmingham.
J. A. Bowers, American Cast Iron Pipe Co., Birmingham.
R. R. Deas, Jr., American Cast Iron Pipe Co., Birmingham.
R. A. Donaldson, Woodward Iron Co., Woodward, Ala.
J. M. Franklin, Central Foundry Co., Holt, Ala.
A. S. Holberg, Alabama Clay Products Co., Birmingham.
Alexander Murdoch, Southern Wheel Div., American Brake Shoe & Foundry Co., Birmingham.
H. A. Nelson, Hill & Griffith Co., Birmingham.
E. A. Thomas, Thomas Foundries, Inc., Birmingham.

Canton District Chapter

(Established 1944)

Chairman—K. F. Schmidt, United Engineering & Foundry Co., Canton, Ohio.
Vice-Chairman—A. H. Lankford, Wooster Products Co., Wooster, Ohio.
Vice-Chairman—H. G. Robertson, American Steel Foundries, Alliance, Ohio.
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W. W. Hoover, Machined Steel Castings Co., Alliance, Ohio.
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H. E. McKimmey, Carnegie-Illinois Corp., Canton, Ohio.
F. J. O'Mara, Canton Malleable Iron Co., Canton, Ohio.
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Edw. H. Taylor, F. E. Myers & Bro. Co., Ashland, Ohio.
Lewis Way, Columbiana Foundry Co., Columbiana, Ohio.

Central Indiana Chapter

(Established 1939)

Chairman—Harold H. Lurie, Cummins Engine Co., Columbus, Ind.
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Central New York Chapter

(Established 1939)

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Chesapeake Chapter

(Established 1940)

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(Established 1934)

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F. B. Skeates, Link Belt Co., Chicago.
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D. H. Lucas, 1511 Touhy Ave., Chicago.
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C. G. Mate, Greenlee Foundry Co., Chicago.

Cincinnati Chapter

(Established 1939)

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Secretary—Jos. Schumacher, Hill & Griffith Co., Cincinnati.
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Charles E. Dine, St. Marys Foundry Co., St. Marys, Ohio.
R. G. Ebersole, Miller & Co., Cincinnati.
Luke D. Fahey, Dayton Castings Co., Dayton, Ohio.
William Gilbert, Jr., Buckeye Foundry Co., Cincinnati.
Charles E. Koehler, Hamilton Brass & Aluminum Castings Co., Hamilton, Ohio.
Arthur Kuhn, Reliable Pattern & Castings Co., Cincinnati.
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Detroit Chapter

(Established 1935)

Chairman—R. G. McElwee, Vanadium Corp. of America, Detroit.
Vice-Chairman—E. C. Hoenicke, Foundry Div. Eaton Mfg. Co., Detroit.
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Secretary—A. H. Allen, Penton Publishing Co., Detroit.
Directors—O. L. Allen, Pontiac Motor Div., General Motors Corp., Pontiac, Mich.
M. E. Brooks, Dow Chemical Co., Bay City, Mich.
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Gordon C. Creusere, Semet-Solvay Co., Detroit.
V. A. Crosby, Climax Molybdenum Co., Detroit.
E. R. Darby, Federal Mogul Corp., Detroit.
F. A. Jensen, National Engineering Co., Detroit.
John E. Linabury, General Motors Corp., Detroit.
F. A. Melmoth, Detroit Steel Casting Co., Detroit.
C. E. Silver, Michigan Steel Casting Co., Detroit.
Harvey J. Miller, Walker Metal Products, Windsor, Ont.
A. W. Stolzenburg, Aluminum Co. of America, Detroit.

Eastern Canada and Newfoundland Chapter

(Established 1942)

Chairman—R. Bernard, La Cie J. A. Gosselin, Ltee., Drummondville, Que.
Vice-Chairman—G. Ewing Tait, Dominion Engineering Works, Lachine, Que.
Secretary-Treasurer—Robt. E. Cameron, Webster & Sons Ltd., Montreal, Que.
Directors—W. Baxter, Crane Ltd., Montreal, Que.
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P. A. Dauncey, Union Screen Plate Co. of Canada Ltd., Lennoxville, Que.
C. V. Hacker, Hull Iron & Steel Foundry Ltd., Hull, Que.
H. Louette, Warden King Ltd., Montreal, Que.
A. C. Neal, Enamel & Heating Products Ltd., Amherst, N. S.
A. Pirrie, Electric Steels Ltd., Cap de la Madeleine, Que.
L. Saindon, Quebec Brass & Iron Foundry Co., Ltd., Levis, Quebec.
G. D. Turnbull, Canadian Car & Foundry Ltd., Montreal, Quebec.
A. R Woods, Canadian Foundry Supplies & Equipment Co. Ltd., Montreal, Que.

Metropolitan Chapter

(Established 1938)

Chairman—T. D. Parker, Climax Molybdenum Co., New York.
Vice-Chairman—Horace A. Deane, American Brake Shoe Co., New York.
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Directors—H. F. Biddle, Foran Foundry & Mfg. Co., Flemington, New Jersey.
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G. Hadzima, Robins Conveyors Inc., Passaic, N. J.
H. C. Harris, Mack Mfg. Co., New Brunswick, N. J.
C. Kline, Cooper Alloy Foundry Co., Elizabeth, N. J.
W. D. Schoonmaker, General Bronze Corp., Corona, Long Island, N. Y.
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R. E. Ward, Eclipse-Pioneer Corp., Teterboro, N. J.
K. V. Wheeler, Jr., American Steel Castings Co., Newark, New Jersey.
D. Yeomans, George F. Pettinos Co., Pluta, Pa.

Michiana Chapter

(Established 1940)

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Vice-Chairman—W. V. Johnson, Oliver Farm Equipment Co., South Bend, Ind.
Secretary-Treasurer—V. S. Spears, American Foundry Equipment Co., Mishawaka, Ind.
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Carl W. Petersen, Dodge Mfg. Corp., Mishawaka, Ind.
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Northeastern Ohio Chapter

(Established 1935)

President—R. F. Lincoln, Russell F. Lincoln & Co., Cleveland.
Vice-President—Wm. E. Goebert, Bowler Foundry Co., Cleveland.
Secretary—Gilbert J. Nock, Nock Fire Brick Co., Cleveland.
Treasurer—F. Ray Fleig, Smith Facing & Supply Co., Cleveland.
Directors—Bruce Aiken, Crucible Steel Casting Co., Cleveland.
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Joseph E. Dvorak, Eberhard Mfg. Co., Cleveland.
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Bert S. Parker, Jr., Youngstown Foundry & Machine Co., Youngstown, Ohio.
H. F. Roberts, Williams Co., Cleveland.
Henry Trenkamp, Ohio Foundry Co., Cleveland.
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J. J. Witenhafer, Lake City Malleable Co., Cleveland.
Elmer Zirzow, National Malleable & Steel Casting Co., Cleveland.

Northern California Chapter

(Established 1935)

President—Ralph C. Noah, San Francisco Iron Foundry, San Francisco, Calif.
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R. W. Goldwater, Industrial Supply Co., San Francisco.
Chas. Hoehn, Jr., Enterprise Engine & Foundry Co., San Francisco.
M. W. Hulse, General Metals Corp., Oakland, Calif.
Wm. Leishman, Pacific Brass Foundry, San Francisco, Calif.
Fred A. Mainzer, Pacific Brass Foundry of San Francisco, San Francisco.
A. M. Ondreyco, Vulcan Foundry Co., Oakland, Calif.

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(Established 1938)

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Treasurer—Glen F. Smith, Mattison Machine Works, Rockford, Illinois.
Directors—Gunnard Anderson, Davey Pump Corp., Rockford, Illinois.
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Lyle Fulton, Geo. D. Roper Corp., Rockford, Ill.
H. L. Klopf, Fairbanks, Morse & Co., Beloit, Wis.
R. J. Looze, Beloit Iron Works, Beloit, Wis.
Max Reuteler, Fairbanks, Morse & Co., Beloit, Wis.
Art C. Rose, National Sewing Machine Co., Belvidere, Ill.
F. N. Rundquist, Beloit Castings Co., Beloit, Wis.
Geo. Schwenkner, Gunite Foundries, Inc., Rockford, Ill.

Ontario Chapter

(Established 1938)

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Vice-Chairman—T. D. Barnes, Foundry Supplies & Equipment, Hamilton, Ont.
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J. Dalby, Canada Metal Co. Ltd., Toronto, Ont.
G. O. Loach, Otis-Fensom Elevator Co. Ltd., Hamilton, Ontario.
L. B. Morris, The Gurney Foundry Co. Ltd., Toronto, Ont.
T. Tafel, Standard Sanitary & Dominion Radiator Ltd., Toronto, Ont.
R. A. Woods, Geo. F. Pettinos (Canada) Ltd., Hamilton, Ontario.
J. A. Wotherspoon, Anthes-Imperial Ltd., St. Catharines, Ontario.
C. O. Williamson, Grinnell Co. of Canada Ltd., Toronto, Ont.

Philadelphia Chapter

(Established 1935)

Chairman—Robert Latham, Bethlehem Steel Co., Bethlehem, Pennsylvania.
Vice-Chairman—John M. Robb, Jr., Hickman, Williams & Co., Philadelphia.
Secretary-Treasurer—W. B. Coleman, W. B. Coleman & Co., Philadelphia.
Directors—B. H. Bartells, University of Pennsylvania, Philadelphia.
R. J. Keeley, Ajax Metal Co., Philadelphia.
C. L. Lane, Florence Pipe Foundry & Machine Co., Florence, N. J.
H. E. Mandel, Pennsylvania Foundry Supply & Sand Co., Philadelphia.
J. W. March, Camden Foundry Co., Camden, N. J.
B. A. Miller, Carmp Brass & Iron Founders Div., Baldwin Locomotive Works, Eddystone, Pa.
E. C. Troy, Dodge Steel Co., Philadelphia.

Quad City Chapter

(Established 1935)

Chairman—R. E. Wilke, Deere & Co., Moline, Ill.
Vice-Chairman—C. E. Von Luhrte, Chicago Retort & Fire Brick Co., Davenport, Iowa.
Secretary-Treasurer—H. L. Creps, Frank Foundries Corp., Moline, Ill.
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C. S. Humphrey, C. S. Humphrey Co., Moline, Ill.
J. N. Johnson, Union Malleable Iron Co., East Moline, Ill.
W. E. Jones, Ordnance Steel Foundry, Bettendorf, Iowa.
Martin Liedtke, International Harvester Co., Rock Island, Illinois.
A. D. Matheson, French & Hecht, Inc., Davenport, Iowa.
A. H. Putnam, A. H. Putnam Co., Rock Island, Ill.
F. W. Shipley, Caterpillar Tractor Co., Peoria, Ill.
R. H. Swartz, Bettendorf Co., Davenport, Iowa.

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(Established 1944)

President—H. B. Hanley, American Laundry Machinery Co., Rochester.
Vice-President—Charles Vaughn, The Ritter Co., Rochester.
Secretary-Treasurer—Donald E. Webster, American Laundry Co., Rochester.
Directors—I. A. Billiar, Symington-Gould Corp., Rochester.
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L. C. Gleason, Gleason Works, Rochester.
Herman Hetzler, Hetzler Foundries, Inc., Rochester.
James McHenry, Gleason Works, Rochester.
Walter Morton, Anstice Co., Inc., Rochester.
Irving Rosenthal, Rochester Smelting & Refining Co., Rochester.
Ernest VanBilliard, Progressive Foundry Co., Rochester.

Saginaw Valley Section, Detroit Chapter

(Established 1944)

Chairman—Chas. Morrison, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich.
Vice-Chairman—E. T. White, Bostick Foundry Co., Lapeer, Michigan.
Secretary-Treasurer—H. G. McMurry, Buick Motor Div., General Motors Corp., Flint, Mich.
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John Smith, Chevrolet Gray Iron Foundry, Saginaw, Mich.
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E. L. Waterhouse, Eaton Mfg. Co., Vassar, Mich.
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(Established 1935)

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Vice-Chairman—W. E. Illig, Banner Iron Works, St. Louis.
Secretary-Treasurer—Chas. E. Rothweiler, Hickman, Williams & Co., St. Louis.
Directors—L. J. Desparois, Pickands, Mather & Co., St. Louis.
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John W. Kelin, Federated Metals Div., American Smelting & Refining Co., St. Louis.
L. A. Kleber, General Steel Castings Corp., St. Louis.
Francis O'Hare, Central Brass & Aluminum Foundry, St. Louis.
Fred Riggan, Key Co., East St. Louis, Ill.
C. B. Shanley, Semi-Steel Casting Co., St. Louis.
C. H. J. Walcher, American Steel Foundries, Granite City, Illinois.
Joseph D. Walsh, Scullin Steel Co., St. Louis.
Harold Wiese, Midvale Mining & Mfg. Co., St. Louis.
J. H. Williamson, M. A. Bell Co., St. Louis.

Southern California Chapter

(Established 1937)

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Secretary—Henry E. Russill, Eld Metal Co., Ltd., Los Angeles.
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J. F. Cassel, Compton Metals Co., Compton, Calif.
L. N. Coleman, Rich Mfg. Co., Los Angeles.
Wm. DeVaney, Joshua Hendy Iron Works, Pomona Pump Co. Div., Pomona, Calif.
Wm. D. Emmett, Los Angeles Steel Castings Co., Los Angeles.
Walter F. Haggman, Foundry Specialties Co., Huntington Park, Calif.
Richard H. Hughes, Almquist Bros. & Viets, Vernon, Calif.
Edgar C. Hummel, Utility Electric Steel Foundry, Los Angeles.

Texas Chapter

(Established 1943)

Chairman—F. M. Wittlinger, Texas Electric Steel Casting Corp., Houston.
Vice-Chairman—J. O. Klein, Texas Foundries, Inc., Lufkin, Texas.
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Jake Dee, Dee Brass Foundry, Houston.
Phil Hawkins, Texas Steel Co., Fort Worth, Texas.
Walter E. Hockmuth, Houston Foundry & Machine Co., Houston.
Robert Lang, Lufkin Foundry & Machine Co., Lufkin, Texas.
R. E. McArdle, McArdle Equipment Co., Houston.
H. L. Roberts, Oil City Iron Works, Corsicana, Texas.
T. W. Russell, Service Pattern & Model Works, Houston.
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Ed. P. Trout, Lufkin Foundry & Machine Co., Lufkin, Texas.

Toledo Chapter

(Established 1941)

Chairman—Leighton Long, Leighton M. Long & Associates, Toledo.
Vice-Chairman—W. P. Mack, Bruce Foundry Co., Tecumseh, Michigan.
Secretary-Treasurer—B. L. Pickett, Unitcast Corp., Toledo.
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R. B. Bunting, Bunting Brass & Bronze Co., Toledo.
Chas. F. Carson, National Supply Co., Toledo.
Floyd F. Ensign, The Ensign Foundry Co., Toledo.
R. T. Jansen, Unitcast Corp., Toledo.
N. P. Mahoney, Maumee Malleable Castings Co., Toledo.
Wm. A. O'Brien, Electric Auto-Lite Co., Fostoria, Ohio.
G. R. Rusk, Freeman Supply Co., Toledo.
V. E. Zang, Unitcast Corp., Toledo.

Twin City Chapter

(Established 1941)

Chairman—A. M. Fulton, Northern Malleable Iron Co., St. Paul.
Vice-Chairman—R. C. Wood, Minneapolis Electric Steel Castings Co., Minneapolis.
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Directors—C. H. Anderson, Crown Iron Works Co., Minneapolis.
Axel F. Carlstrom, Smith-Sharpe Co., Minneapolis.
I. F. Cheney, Griffin Wheel Co., St. Paul.
J. S. Garske, Progress Pattern & Foundry Co., St. Paul.
Fulton Holtby, University of Minnesota, Minneapolis.
R. W. Jones, Jr., St. Paul Engineering & Mfg. Co., St. Paul.
Herbert Larson, Minneapolis-Moline Power Implement Co., Minneapolis.
H. M. Patton, American Hoist & Derrick Co., St. Paul.
J. F. Staver, Staver Foundry Co., Virginia, Minn.
R. C. Wood, Minneapolis Electric Steel Castings Co., Minneapolis.

Western Michigan Chapter

(Established 1941)

Chairman—J. L. Brooks, Muskegon Piston Ring Co., Sparta, Michigan.
Vice-Chairman—A. E. Jacobson, Grand Haven Brass Foundry, Grand Haven, Mich.
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Treasurer—Vern L. Tietsort, Campbell Wyant & Cannon Foundry Co., Muskegon, Mich.
Directors—Max A. Amos, Standard Automotive Parts Co., Muskegon, Mich.
Harold BeMent, Campbell Wyant & Cannon Foundry Co., Muskegon, Mich.
J. L. Brooks, Muskegon Piston Ring, Sparta Div., Sparta.
R. R. Campbell, Centrifugal Casting Co., Muskegon, Mich.
R. A. Clark, Lakey Foundry & Machine Co., Muskegon.
R. W. Hathaway, Federal Mogul Co., Greenville, Mich.
J. C. Jensen, Battle Creek Foundry Co., Battle Creek, Mich.
H. J. Krause, Newago Engineering Co., Newago, Mich.
George W. Myers, West Michigan Steel Castings Co., Muskegon, Mich.
H. N. Myers, Sealed Power Corp., Muskegon, Mich.
Fred Papke, Wolverine Brass Co., Grand Rapids, Mich.

Western New York Chapter

(Established 1937)

Chairman—Reinhold D. Loesch, Lake Erie Foundry Co., Buffalo.
Vice-Chairman—Arthur H. Suckow, Symington-Gould Corp., Depew, N. Y.
Secretary—J. Ralph Turner, Queen City Sand & Supply Co., Buffalo.
Treasurer—Martin W. Pohlman, Pohlman Foundry Co., Inc., Buffalo.
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Alfred A. Diebold, Atlas Steel Casting Co., Buffalo.
Milton S. Finley, Werner G. Smith Co., Buffalo.
Elliot R. Jones, Lumen Bearing Co., Buffalo.
Harold R. King, Metal & Alloy Specialties Co. Inc., Buffalo.
Everett E. LeViness, Combined Supply & Equipment Co., Inc., Buffalo.
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Martin J. O'Brien, Symington-Gould Corp., Depew, N. Y.
Harold J. Struebing, Electro Refractories & Alloys Corp., Buffalo.

Wisconsin Chapter

(Established 1935)

President—Harry E. Ladwig, Allis-Chalmers Mfg. Co., Milwaukee.
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G. K. Dreher, Ampco Metal, Inc., Milwaukee.
A. M. Fischer, Chas. Jurack Co., Milwaukee.
Arthur C. Haack, Wisconsin Grey Iron Foundry Co., Milwaukee.
E. B. Hansen, Wisconsin-Appleton Co., South Milwaukee.
L. D. Harkrider, General Malleable Co., Waukesha, Wis.
Paul Rice, Milwaukee Chaplet & Mfg. Co., Milwaukee.
Robert C. Woodward, Bucyrus Erie Co., South Milwaukee.

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Don't forget now, Chapter Leaders, mail your picture to National Headquarters, 222 West Adams St., Chicago.

Abstracts

NOTE: The following references to articles dealing with the many phases of the foundry industry, have been prepared by the staff of *American Foundryman*, from current technical and trade publications.

When copies of the complete articles are desired, photostat copies may be obtained from the Engineering Societies Library, 29 W. 39th Street, New York, N. Y.

Aluminum

PLANT DESCRIPTION. *"Dodge Aluminum Foundry Has Flexibility,"* A. H. Allen, THE FOUNDRY, vol. 72, no. 7, July, 1944, pp. 80-82, 178.

The author describes the layout and some of the foundry practices used in a fully conveyorized aluminum foundry operated by the Dodge Division of Chrysler Corporation.

Apprentice Training

BRITISH. *(See Training.)*

Brass and Bronze

PISTON RINGS. *"Bronze Foundry Exercises Close Control,"* R. T. Covington, THE FOUNDRY, vol. 72, no. 7, July, 1944, pp. 76-78, 198, 200.

At the onset of the war, a bronze foundry producing piston rings found it necessary to revamp the shop in order to increase the output of piston rings. The author has described what changes were made in order to produce high quality piston rings on a 24 hour operating basis.

MELTING CONTROL. *"Metallurgy in the Non-Ferrous Foundry,"* A. C. Boak, CANADIAN METALS AND METALLURGICAL INDUSTRIES, vol. 7, no. 5, May, 1944, pp. 27-30.

Copper-base alloys should be melted under carefully controlled slightly oxidizing atmospheres. Reducing atmospheres and all practices which produce reducing gases should be avoided. Excessive oxidation should likewise be avoided, since it will result in large melting losses and increased melting time. The degree of oxidation can be controlled by means of furnace design, fuel supply, charging method, and holding the metal in the furnace.

MELTING. *"Melt Bronze in the Cupola,"* Charles Gregg, THE FOUNDRY, vol. 72, no. 7, July, 1944, pp. 89, 210, 212, 214.

Bronze can be melted successfully in a cupola provided all precautions to control the composition of the molten metal are observed. The author describes in detail the cupola practice for melting bronze and points out practices which differ from those ordinarily used in iron melting.

PLANT DESCRIPTION. *"Melts 100 Tons of Bronze Daily,"* Pat Dwyer, THE FOUNDRY, vol. 72, no. 6, June, 1944, pp. 127-129, 280, 282.

A description of the foundry and some of the foundry practices used by the St. Louis plant of the National Bearing Metals Corp. The plant makes nonferrous castings for military and naval requirements in a large variety of alloys, shapes, and weights.

SULPHUR DETERMINATION. *"Determine Sulphur in Brass and Bronze by Combustion Method,"* Albert C. Holler and James P. Yeager, THE FOUNDRY, vol. 72, no. 8, August, 1944, pp. 83, 208, 210, 212.

A rapid and accurate method for determining the sulphur content of brass and bronze is the combustion method. A sample of the brass or bronze is placed in a combustion boat and heated in a combustion tube in a stream of oxygen to a temperature at which sulphides are oxidized to sulphur dioxide. The sulphur dioxide then passes through a gas purifying train to an absorber where hydrogen peroxide oxidizes the sulphur dioxide to sulphur trioxide, which in turn combines with water to form sulphuric acid. The sulphuric acid is then titrated with a standardized sodium hydroxide solution, using bromcresol green as in indicator.

The apparatus and techniques used are described in detail.

ZINC LOSS. *"Zinc Fume in the Foundry,"* W. G. Mochrie, FOUNDRY TRADE JOURNAL, vol. 73, no. 1449, May 25, 1944, pp. 71-72.

The author discusses the effect of varying degrees of zinc fume evolution on the mechanical properties and microstructure of manganese bronze castings.

Cast Iron

CYLINDER HEADS. *"Pours Finned Cylinders of Alloy Cast Iron,"* Edwin Bremer, THE FOUNDRY, vol. 72, no. 6, June, 1944, pp. 116-119, 260.

A discussion of the sand, molding, core, and pouring practice used to produce finned cylinders and cylinder heads of gray cast iron.

Cast Steel

HEAT TREATMENT. *(See Heat Treatment.)*

Chemical Analysis

SULPHUR. *(See Brass and Bronze.)*

Converters

SIDE-BLOWN. *(See Steel.)*

Core Practice

MECHANICAL AIDS. *"Mechanical Aids to Core Production,"* J. Blakiston, FOUNDRY TRADE JOURNAL, vol. 73, no. 1448, May 18, 1944, pp. 43-48, 56; no. 1449, May 25, 1944, pp. 63-67.

A description of mechanical aids used in making and transporting sand cores. Equipment described includes conveyors, core plates, core benches, spray guns, molding machines, turnover cages, core ovens, and core barrel machines.

Corrosion

PREVENTION. *(See Steel.)*

Cupola

BRONZE MELTING. *(See Brass and Bronze.)*

Defects

CASTING. *(See Sand.)*

Education

APPRENTICE TRAINING. *(See Training.)*

Foundry Practice

ECONOMY. *"Modern Foundry Practice,"* C. R. Day, FOUNDRY TRADE JOURNAL, vol. 72, no. 1443, April 13, 1944, pp. 311-314, 316, 318.

After visiting foundries in England, France, United States, and Germany during 1937, the author wrote this description of mechanization methods used in handling foundry materials in order to increase production and reduce production costs.

Fuels

RECLAMATION OF SLACK COAL. *"Utility Briquettes from Waste Slack,"* H. B. Farmer, FOUNDRY TRADE JOURNAL, vol. 73, no. 1448, May 18, 1944, pp. 55-56.

The author describes a method of forming slack coal into briquettes which may be used in place of large coal for such operations as cupola lighting, ladle and spout drying, and lighting ovens.

Gray Iron

CUPOLA PRACTICE. *"Cupola Practice,"* Donald J. Reese, FOUNDRY TRADE JOURNAL, vol. 73, no. 1448, May 18, 1944, pp. 49-54.

The author defends the cupola as a continuous melting furnace for use in iron foundries, describes the potential performance of a cupola, and discusses the importance of accurately computing and weighing charges of raw materials. He outlines the technique for cupola operation and describes the conditions within the cupola during melting.

INGOT MOLDS. *"Bethlehem Casts Largest Ingot Mold,"* THE FOUNDRY, vol. 72, no. 5, May, 1944, pp. 70-71, 178.

A description of the foundry practice used in producing the largest ingot mold ever made by the Bethlehem Steel Co.

PRODUCTION PROBLEMS. *"Increasing Gray Iron Production Through Modernization,"* Edward C. Hoenicke, THE FOUNDRY, vol. 72, no. 6, June, 1944, pp. 133, 262, 264, 266, 268.

At the present time gray iron foundries are faced with the need for producing a greater tonnage of iron castings than their available manpower is capable of producing under the conditions which exist in the majority of gray iron foundries. Consequently they should consider the possible benefits which may result from improved working conditions and plant layout.

The author has described a procedure whereby the foundry operator may determine whether his plant is functioning at maximum efficiency and what changes would make possible an increased output.

PROMOTION. *"The Competitive Position of Gray Iron,"* Donald J. Reese, THE FOUNDRY, vol. 72, no. 5, May, 1944, pp. 65, 166, 168, 172, 174, 176.

This paper was presented before the New Jersey Foundrymen's Association at Newark, N. J., February 28.

The author has reviewed the progress made by various branches of the foundry industry since the start of the war. He calls attention to the fact that gray iron is a neglected engineering material of greater merit than is popularly believed and points out that it is up to the gray iron producers to acquaint potential users with its true value.

Heat Treatment

MALLEABLE IRON. *(See Malleable Iron.)*

STEEL CASTINGS. *"Developments in the Water Quenching of Steel Castings,"* Charles W. Briggs, THE FOUNDRY, vol. 72, no. 5, May, 1944, pp. 58-59, 132.

The author gives the history of water quenching of commercial steel castings for the past 35 years, and predicts the extent of post-war applications of water quenching of steel castings.

STEEL CASTINGS. *"Problems in Water Quenching Miscellaneous Sized Steel Castings,"* W. B. Libert, THE FOUNDRY, vol. 72, no. 6, June, 1944, pp. 130-131, 256, 258.

The author has described the water quenching practice used by his foundry on various sizes of steel castings.

Heat Treatment

STEEL CASTINGS. *"Water-Quenching Small Steel Castings,"* J. W. Juppenlatz, THE FOUNDRY, vol. 72, no. 7, July, 1944, pp. 84-87, 174.

The author describes the procedures used for water quenching small steel castings. He emphasizes the following limiting factors: Use of heat treatment furnaces of uniform temperature and adequate heat control; prompt transfer from the quenching furnace at quenching temperatures to the water; water quench with known rates of cooling (temperature of water and velocity), to avoid vapor pockets; time-temperature quench for mass and irregular sections involved; and draw without delay.

Inspection

NON-DESTRUCTIVE. *(See Radiography.)*

Magnesium

FOUNDRY TECHNIQUES. *"Producing Magnesium Castings."* CANADIAN METALS AND METALLURGICAL INDUSTRIES, vol. 7, no. 5, May, 1944, pp. 24-27.

A description of the melting, sand practice, cleaning, finishing, and inspection of magnesium castings at the Robert Mitchell Co., Ltd.

PLANT DESCRIPTION. *"Magnesium Castings by Dodge Chicago Plant,"* William G. Gude, THE FOUNDRY, vol. 72, no. 8, August, 1944, pp. 78-81, 178, 180.

A detailed description of the layout of a magnesium foundry producing castings for aircraft engines.

Malleable Iron

GRAPHITIZING. *"Speeding Graphitization of Malleable Iron,"* C. H. Lorig, THE FOUNDRY, vol. 72, no. 5, May, 1944, pp. 60-61, 144, 148, 150, 152, 154, 158, 160.

A discussion of the foundry operations and the metallurgical factors which control the annealing time for malleable iron.

Materials Handling

STEEL FOUNDRY. *"Handling Materials in the Crane Steel Foundry,"* Efle F. Ross, THE FOUNDRY, vol. 72, no. 7, July, 1944, pp. 74-77, 182, 184, 186, 188.

An account of the manner in which the Crane Steel Foundry increased its output by adopting more efficient methods and installing more efficient equipment without resorting to the construction of new buildings. Considerable emphasis was placed on the mechanical handling of materials and every possible attempt was made to utilize all available floor space.

Melting

CUPOLA PRACTICE. *(See Gray Iron.)*

Metallography

COLOR PHOTOGRAPHY. *"Metallography in Color,"* R. P. Loveland, A.S.T.M. BULLETIN, no. 128, May 1944, pp. 19-29.

A discussion of the separation negative method, screen plate processes, and integral tripack processes of color photography and their metallographic applications.

Molding

MACHINES. *(See Foundry Practice.)*

Non-Ferrous

MANGANESE BRONZE. *(See Brass and Bronze.)*

Photography

COLOR. *(See Metallography.)*

Radiography

INSPECTION. *"X-Ray Process Engineering,"* Robert Taylor, THE FOUNDRY, vol. 72, no. 5, May, 1944, pp. 74, 141-142.

History of radiography as an industrial inspection tool and factors responsible for the success of radiographic technique.

Research

TOLERANCES. *(See Tolerances.)*

Risering

OPEN RISERS. *"Graphite Rods Applied to Open Risers,"* Frank J. Vosburgh and Harold L. Larson, THE FOUNDRY, vol. 72, no. 7, July, 1944, pp. 74-75, 180, 182, 184, 186.

The authors have discussed a series of experiments performed to adapt the use of graphite rods to open risers. These experiments showed that the use of graphite rods permitted the use of smaller risers, thus reducing the amount of metal needed and the time necessary for riser removal. The types of rods and their method of use are completely described.

Sand

CASTING DEFECTS. *"Moulding Sands and Gases in Relation to Casting Defects,"* G. W. Nicholls, FOUNDRY TRADE JOURNAL, vol. 73, no. 1450, June 1, 1944, pp. 85-91; no. 1451, June 8, 1944, pp. 111-114, 116.

This paper discusses the relationship between sand condition and various types of casting defects. It emphasizes the importance of the characteristics of mold materials at molten metal temperatures.

SYNTHETIC. *"The Effect of Grain Shape on the Moulding Properties of Synthetic Moulding Sands,"* W. Davies and W. J. Rees, THE IRON AND STEEL INSTITUTE, Paper No. 8/1944 of the Steel Castings Research Committee, Advance Copy, June, 1944, 29 pages.

The influence of grain shape on the behavior of sands in synthetic molding

sand mixtures bonded with clays, core oils and core compounds has been investigated, using the recently developed method of Robertson and Emodi for the assessment of grain shape. The grain angularity is shown to vary with the source from which the sand was derived originally, the conditions under which the sand deposit accumulated and the degree of consolidation of the deposit.

Typical examples of the effect of grain shape on the properties of synthetic molding and core sand mixtures are given, and it is shown that for sands having comparable mechanical gradings the strength of mixtures prepared with angular sands is lower than that of mixtures based on rounded sands, and that the surface friability of the dried mold or core increases with the angularity of the sand. These differences are attributed to the poorer packing properties of the angular sands and to differences in the grain relationships in angular and rounded sands.

The distribution of bulk density in molds and cores is analyzed, and the relationship of the bulk-density gradient to the molding properties is discussed and illustrated.

Some methods of minimizing the disadvantageous effect of angularity of grain are suggested.

Steel

CONVERTER PLANT DESIGN. *"Developments in the Design and Use of Side-Blown Converter Plants,"* P. C. Fassotte, THE IRON AND STEEL INSTITUTE, Advance Copy, June, 1944, 10 pages.

A shortage of hematite iron at the time when the new converter plants had to be erected led to a re-assessment of the relative importance of the silicon and carbon reactions in the process. It was established that the carbon reaction leads essentially to the formation of carbon dioxide. The temperature increment derived from this carbon combustion is such that this reaction may be relied upon principally to produce the final steel temperature. Plants were therefore built in such a way that silicon could be largely dispensed with, with the concomitant elimination of hematite from the cupola charges. The operation of such a plant is discussed.

CORROSION INHIBITORS. *"The Formulation of Anti-Corrosive Compositions for Ships' Bottoms and Underwater Service on Steel,"* F. Fancutt and J. C. Hudson, THE IRON AND STEEL INSTITUTE, Paper No. 13/1944 of the Corrosion Committee, Advance Copy, June, 1944, 65 pages.

This paper is the first of a series in which the results of the Marine Corrosion Sub-Committee's investigations on formulated ships' anti-corrosive compositions will be reported. It deals specifically with anti-corrosive compositions; the subect of anti-fouling compositions will be discussed in later contributions relating to other work now in progress.

The results of the Sub-Committee's researches to date on formulated anti-corrosive compositions lead to the following general conclusions:

(1) The pigment should be inhibitive in character, but may with advantage be diluted with neutral pigments or extenders, provided that the proportion of inhibitor is not excessively reduced. Basic lead sulphate is a valuable pigment for this type of service, and entered into two of the best formulations in a series in which 77 different pigment combinations were incorporated in the same modified phenolic-resin medium. These two paints were pigmented, respectively, with (a) 8 parts of basic lead spulphate, 2 parts of aluminum and 3 parts of barytes, and (b) 2 parts of white lead, 4 parts of basic lead sulphate and 4 parts of Burntisland red.

(2) Of the range of media so far tested the best have proved to be various types of phenolic- or coumarone-resin varnish and one containing chlorinated rubber.

Further tests are in progress with a view to determining the best combinations of pigment and medium.

Steel

HARDENABILITY *"Hardenability from Cast Specimens,"* E. S. Rowland, THE IRON AGE, vol. 153, no. 19, May 11, 1944, pp. 61-65.

A description of the equipment and technique in use at the Timken Roller Bearing Co. for casting Jominy end-quench specimens. Graphs showing typical results from cast and forged hardenability tests are included.

PLANT DESCRIPTION. *"Modern Design Marks New Steel Foundry,"* Pat Dwyer, THE FOUNDRY, vol. 72, no. 5, May, 1944, pp. 66-67, 128, 130.

A description of a new foundry built by the Symington-Gould Corp., Rochester, N. Y., for the production of low alloy steel castings.

TORCH CUTTING. *"Oxyacetylene Use in the Steel Foundry,"* G. E. Bellew, THE FOUNDRY, vol. 72, no. 6, June, 1944, pp. 129-122, 254.

A description of recently developed applications of the oxyacetylene torch in the steel foundry. Applications described include the use of machine torch cutting, adequate jigs and fixtures, flame gouging to gouge out defects prior to filling them with weld metal, a descaling head for removing the scale covering from heat treated castings, and the oxygen lance to pierce tap holes in furnaces or ladles, to cut through extra heavy sections, or to remove heats which are lost in the furnace.

WATER QUENCHING. *(See Heat Treatment.)*

Temperature Measurement

CASTING STREAM TEMPERATURES. *"A Thermocouple Method for the Measurement of Liquid Steel Casting-Stream Temperatures,"* D. A. Oliver and T. Land, FOUNDRY TRADE JOURNAL, vol. 73, no. 1446, May 4, 1944, pp. 3-6.

A simple method for measuring the temperature of a stream of molten metal by means of a thermocouple has been devised. Essentially the method consists of pouring the molten metal through a refractory runner box of circular cross section in which protected thermocouple wires are embedded in such a way that the head of the thermocouple may project into the pouring stream. It is important that the thermocouple be provided with a high-speed temperature recorder and that pouring be continued long enough to permit the thermocouple to attain a steady temperature.

Temperatures obtained by means of a thermocouple in a metal stream are free from the errors which result from metal composition, degree of surface oxidation, and smoke when determining temperatures by means of an optical pyrometer.

Thermocouples

STEEL TEMPERATURES. *(See Temperature Measurement.)*

Tolerances

PRINCIPLES OF. *"Tolerances and Inaccuracies of Physics,"* Sir Charles G. Darwin, FOUNDRY TRADE JOURNAL, vol. 73, no. 1454, June 29, 1944, pp. 169-174.

This is the Edward Williams lecture delivered to the Forty-first Annual Meeting of the Institute of British Foundrymen. The author has described the principles and importance of tolerances in science and industry. The discussion which followed the reading of this article is appended.

Training

APPRENTICE. *"Views on Foundry Training,"* R. F. Coates, FOUNDRY TRADE JOURNAL, vol. 73, no. 1451, June 8, 1944, pp. 105-110, 116.

The author submits a plan for training foundry apprentices in such a way that British foundries will be fully prepared to take part in post-war manufacturing.

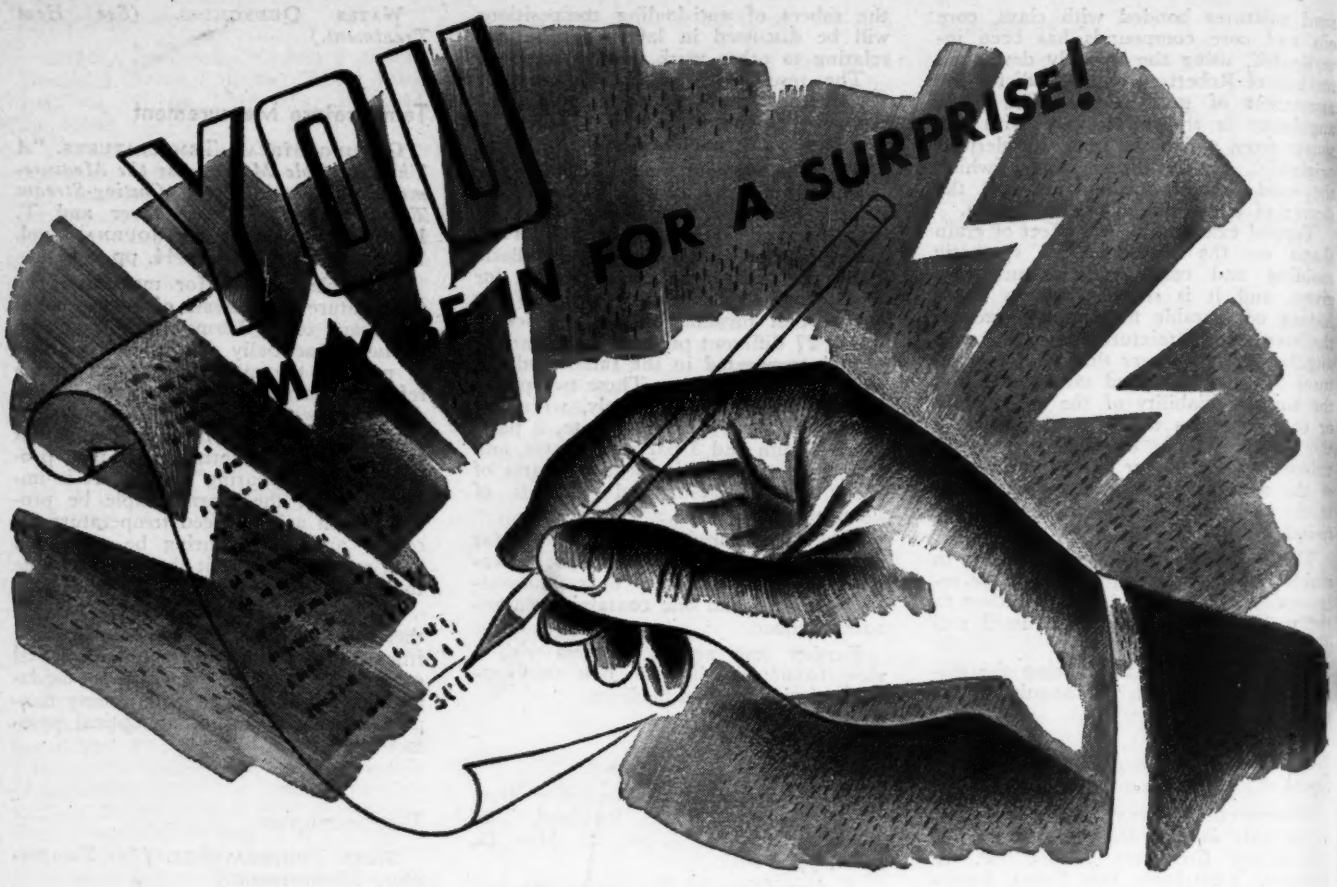
X-ray

INSPECTION. *(See Radiography.)*

September Chapter Meetings

September 13
New England Foundrymen's Association
Engineers Club, Boston
Round Table Meeting

September 16
Michiana
Elkhart Country Club, Elkhart, Ind.
Annual Outing



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